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By Authority of the  
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Certifying Officer

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PTO/SB/16 (8-00)

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**PROVISIONAL APPLICATION FOR PATENT COVER SHEET**

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

22713 U.S. PTO  
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<input checked="" type="checkbox"/> Additional inventors are being named on the <u>1</u> separately numbered sheets attached hereto.					
TITLE OF THE INVENTION (280 characters max)					
APPARATUS AND METHOD FOR LOW TEMPERATURE DE-ICING					
Direct all correspondence to:			CORRESPONDENCE ADDRESS		
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<input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number:				01-0035	
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The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.					
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Respectfully submitted,

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Date

January 6, 2005

REGISTRATION NO.

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Docket Number:

206,830

**USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT****STATEMENT OF FILING BY EXPRESS MAIL 37 C.F.R. § 1.10**

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**PROVISIONAL APPLICATION COVER SHEET**  
*Additional Page*

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Docket Number		206,830	Type a plus sign (+) inside this box →	+
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Number 2 of 2

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## APPARATUS AND METHOD FOR LOW TEMPERATURE DE-ICING

### PART A – STRUCTURE OF THIS PROVISIONAL

In order to submit this provisional, we are employing the approach as explained below.

We begin by taking recourse to an earlier PCT (PCT/IL03/00854 - COLB 47895 - MICROHEAT 5C) submitted by Microheat Inc., namely the one named "Apparatus and Method for Cleaning or De-icing Vehicle Elements" (hereinafter "PCT").

Referring to Part B, see the text pages 1 to 57 and the figures from Fig. No. 1 to Fig. No. 24H.

Said PCT is incorporated in the present provisional in full, forming Part B of this document. In this provisional we include the complete text of the former PCT, up to its claims, which are not included inhere under,

In addition, we do include all the figures of said PCT, starting with figure No. 1 and up to figure 24H, inclusive.

As said, the above (text and drawings) constitute "Part B" of the current provisional.

Referring to Part C, see the text pages 58 to page 83, and figures No. 25 to No. 31B.

Part C of this provisional constitutes the added subject matter of previous U.S. Provisional Application 60/544,438, filed February 12, 2004, titled "Apparatus and Method for Low Temperature De-Icing" (COLB 50839 - MICROHEAT 6A).

As said, the above (text and drawings) constitute "Part C" of the current provisional.

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Referring to Part D, see the text pages 84 – 106, and the figures from Fig. No. 32 to Fig. No. 41B.

Part D of the provisional constitutes the new, added subject matter of this provisional.

Part D, hence, is made up of the components (standard sections) provided in any common provisional.

This approach – presenting the three parts, was selected in order to alleviate the task of expected future consolidation of an application, when going over from the provisional to the PCT.

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PART B – THE REFERRED TO PCT (PCT/IL03/00854 - COLB 47895 – MICROHEAT 5C)

The PCT (without the claims), i. e. pages 1 to 57 are presented in the following pages.

Figures No. 1 to No. 24H will be entered at the end of the document (following all the written texts material).

Part C THE PREVIOUS PROVISIONAL (U.S. 60/544,438 - COLB 50839 - MICROHEAT 6A)

The added provisional's matter (with it claims), i. e. pages 58 to 83 are presented in the following pages.

Figures No. 25 to No. 31B will be entered at the end of the document (following all the written texts material).

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Part D THE PROVISIONAL'S ADDED MATTER (COLB 51677 - MICROHEAT 6B)

The added provisional's matter (with it claims), i. e. pages 84 to 106 are presented in the following pages.

Figures No. 32 to No. 41B will be entered at the end of the document (following all the written texts material).

APPARATUS AND METHOD FOR CLEANING OR DE-ICING VEHICLE  
ELEMENTS

REFERENCE TO CO-PENDING APPLICATIONS

Applicant hereby claims priority of U.S. Provisional Patent Application  
Serial No. 60/451,600 filed on March 3, 2003, entitled "System And Method For Swift  
Cleaning Or De-Icing Windshields" and U.S. Provisional Patent Application Serial No.  
60/420,001, filed October 21, 2002, entitled " System And Method For Swift Cleaning  
Or Deicing Windshields ".

FIELD OF THE INVENTION

The present invention relates generally to apparatus and method for  
cleaning or de-icing vehicle elements.

BACKGROUND OF THE INVENTION

The following publications are believed to represent the current state of  
the art:

U.S. Patents: 6,164,564; 6,199,587; 5,509,606; 5,118,040; 4,090,668;  
5,012,977; 5,354,965; 3,979,068; 4,090,668; 4,106,508; 5,012,977; 5,118,040;  
5,254,083; 5,354,965; 5,383,247; 5,509,606; 5,927,608; 5,947,348 and 5,988,529.

Published PCT Applications: WO 02/092237, WO 00/27540 and WO  
98/58826.

## SUMMARY OF THE INVENTION

5 The present invention seeks to provide improved apparatus and method for cleaning or de-icing vehicle elements.

There is thus provided in accordance with a preferred embodiment of the present invention a liquid heating assembly including a heat-conductive displaceable element and a liquid heating enclosure defining a liquid heating volume including a primary liquid heating volume portion and a secondary liquid heating volume portion,  
10 separated by the heat-conductive displaceable element, the primary liquid heating volume portion including a heat exchanger for directly heating liquid in the primary liquid heating volume portion and for indirectly heating liquid in the secondary liquid heating volume portion via the heat-conductive displacement element.

In accordance with another preferred embodiment of the present  
15 invention the heat-conductive displaceable element includes a resilient, flexible element. Additionally or alternatively, the heat-conductive displaceable element forms at least a wall both of the primary liquid heating volume portion and of the secondary liquid heating volume portion.

In accordance with yet another preferred embodiment of the present  
20 invention at least the liquid heating enclosure defines a primary liquid flow pathway in the primary liquid heating volume portion and a secondary liquid flow pathway in the secondary liquid heating volume portion, the secondary liquid flow pathway supplying liquid to the primary liquid flow pathway.

Preferably, the primary liquid heating volume portion is formed of a  
25 relatively rigid, highly heat conductive material. Additionally, the secondary liquid heating volume portion is formed of a material which is less rigid and less heat conductive than the material forming the primary liquid heating volume portion.

In accordance with another preferred embodiment of the present  
invention at least the primary liquid flow pathway is defined by the liquid heating  
30 enclosure and by the heat-conductive displacement element. In accordance with yet another preferred embodiment of the present invention at least the liquid heating enclosure defines an at least partially turbulent flow primary liquid flow pathway in the

primary liquid heating volume portion and an at least partially turbulent flow secondary liquid flow pathway in the secondary liquid heating volume portion, the at least partially turbulent flow secondary liquid flow pathway supplying liquid to the at least partially turbulent flow primary liquid flow pathway.

5 In accordance with still another preferred embodiment of the present invention the primary liquid heating volume portion is formed at least partially of a metal material, which is relatively highly heat conductive and the secondary liquid heating volume portion is formed at least partially of a plastic material, which is relatively heat insulative, separated by the heat-conductive displaceable element,  
10 formed of a material which is less heat conductive than the metal material. Additionally, the heat-conductive displaceable element is formed of a material which is more heat conductive than the plastic material.

In accordance with another preferred embodiment of the present invention the heat-conductive displaceable element is apertured to permit liquid  
15 communication from the secondary liquid heating volume portion to the primary liquid heating volume portion.

In accordance with another preferred embodiment of the present invention the secondary liquid heating volume portion includes at least one displaceable outer wall portion providing freeze protection by virtue of its displaceability.  
20 Additionally, the heat-conductive displaceable element is operative to be displaced into the secondary liquid heating volume portion upon freezing of liquid inside the primary liquid heating volume portion.

In accordance with yet another preferred embodiment of the present invention the heat-conductive displaceable element is an intervening liquid  
25 impermeable diaphragm.

In accordance with still another preferred embodiment of the present invention the primary liquid heating volume portion is a first conduit element and the secondary liquid heating volume portion is a second conduit element. Additionally, the heat exchanger is defined by the first conduit element and the second conduit element.

30 There is also provided in accordance with another preferred embodiment of the present invention vehicle including a vehicle chassis including a drive train, a vehicle body including at least one vehicle surface which requires washing, a vehicle

washing liquid reservoir, a vehicle washing liquid discharge assembly, a vehicle surface washer assembly operative to employ the vehicle washing liquid discharge assembly and a washing liquid from the vehicle washing liquid reservoir for washing the at least one vehicle surface which requires washing and a liquid heating assembly operative to  
5 employ the vehicle washing liquid discharge assembly and the washing liquid from the vehicle washing liquid reservoir for providing a spray of heated liquid onto the at least one vehicle surface which requires washing, the liquid heating assembly including a heat-conductive displaceable element and a liquid heating enclosure defining a liquid  
10 heating volume including a primary liquid heating volume portion and a secondary liquid heating volume portion, separated by the heat-conductive displaceable element, the primary liquid heating volume portion including a heat exchanger for directly heating liquid in the primary liquid heating volume portion and for indirectly heating liquid in the secondary liquid heating volume portion via the heat-conductive displacement element.

15 There is further provided in accordance with yet another preferred embodiment of the present invention a vehicle including a vehicle chassis including a drive train, a vehicle body including at least one vehicle surface which requires washing, a vehicle washing liquid reservoir, a vehicle washing liquid discharge assembly, a vehicle surface washer assembly operative to employ the vehicle washing  
20 liquid discharge assembly and a washing liquid from the vehicle washing liquid reservoir for washing the at least one vehicle surface which requires washing, a liquid heating assembly operative to employ the vehicle washing liquid discharge assembly and the washing liquid from the vehicle washing liquid reservoir for providing a spray of heated liquid onto the at least one surface which requires washing and a normally  
25 closed automatically operative valve interconnecting the vehicle washing liquid reservoir to the vehicle washing liquid discharge assembly and being operative, when open, to bypass the liquid heating assembly.

In accordance with another preferred embodiment of the present invention the vehicle also includes a vehicle pump connected upstream of the at least  
30 one vehicle washing liquid reservoir and downstream of the normally closed automatically operative valve. Additionally or alternatively, the liquid heating assembly includes a heat-conductive displaceable element and a liquid heating enclosure defining

a liquid heating volume including a primary liquid heating volume portion and a secondary liquid heating volume portion, separated by the heat-conductive displaceable element, the primary liquid heating volume portion including a heat exchanger for directly heating liquid in the primary liquid heating volume portion and for indirectly heating liquid in the secondary liquid heating volume portion via the heat-conductive displacement element.

Preferably, the heat-conductive displaceable element includes a resilient, flexible element. Additionally or alternatively, the heat-conductive displaceable element forms at least a wall both of the primary liquid heating volume portion and of the secondary liquid heating volume portion.

In accordance with yet another preferred embodiment of the present invention at least the liquid heating enclosure defines a primary liquid flow pathway in the primary liquid heating volume portion and a secondary liquid flow pathway in the secondary liquid heating volume portion, the secondary liquid flow pathway supplying liquid to the primary liquid flow pathway.

In accordance with still another preferred embodiment of the present invention the primary liquid heating volume portion is formed of a relatively rigid, highly heat conductive material. Additionally, the secondary liquid heating volume portion is formed of a material which is less rigid and less heat conductive than the material forming the primary liquid heating volume portion.

In accordance with another preferred embodiment of the present invention at least the primary liquid flow pathway is defined by the liquid heating enclosure and by the heat-conductive displacement element. Additionally or alternatively, at least the liquid heating enclosure defines an at least partially turbulent flow primary liquid flow pathway in the primary liquid heating volume portion and an at least partially turbulent flow secondary liquid flow pathway in the secondary liquid heating volume portion, the at least partially turbulent flow secondary liquid flow pathway supplying liquid to the at least partially turbulent flow primary liquid flow pathway. Additionally or alternatively, the primary liquid heating volume portion is formed at least partially of a metal material, which is relatively highly heat conductive and the secondary liquid heating volume portion is formed at least partially of a plastic material, which is relatively heat insulative, separated by the heat-conductive

displaceable element, formed of a material which is less heat conductive than the metal material. Preferably, the heat-conductive displaceable element is formed of a material which is more heat conductive than the plastic material.

5 In accordance with yet another preferred embodiment of the present invention the heat-conductive displaceable element is apertured to permit liquid communication from the secondary liquid heating volume portion to the primary liquid heating volume portion. Additionally or alternatively, the secondary liquid heating volume portion includes at least one displaceable outer wall portion providing freeze protection by virtue of its displaceability. Additionally, the heat-conductive displaceable  
10 element is operative to be displaced into the secondary liquid heating volume portion upon freezing of liquid inside the primary liquid heating volume portion.

In accordance with still another preferred embodiment of the present invention the at least one vehicle surface which requires washing includes at least one of the following surfaces: a front vehicle windshield surface, a back vehicle windshield  
15 surface, a side vehicle window surface, a vehicle headlight surface, a vehicle rear light surface, a vehicle radar antenna surface and a vehicle exterior mirror surface.

In accordance with still another preferred embodiment of the present invention the heat-conductive displaceable element is an intervening liquid impermeable diaphragm. In accordance with yet another preferred embodiment of the  
20 present invention the primary liquid heating volume portion is a first conduit element and the secondary liquid heating volume portion is a second conduit element. Additionally, the heat exchanger is defined by the first conduit element and the second conduit element.

In accordance with another preferred embodiment of the present  
25 invention the normally closed automatically operative valve is a differential pressure responsive one-way valve.

In accordance with still another preferred embodiment of the present invention user activation activates the spray of heated liquid onto the at least one vehicle surface which requires washing. Additionally or alternatively, automatic activation  
30 activates the spray of heated liquid onto the at least one vehicle surface which requires washing. Preferably, the automatic activation is provided by an AGC actuation signal.

In accordance with yet another preferred embodiment of the present invention the liquid heating assembly is operative to employ the vehicle washing liquid discharge assembly and the washing liquid from the vehicle washing liquid reservoir for providing a spray of liquid onto a vehicle windshield surface and a vehicle radar antenna surface.

In accordance with still another preferred embodiment of the present invention the vehicle also includes a normally-open valve interconnecting vehicle windshield sprayers of the vehicle windshield surface to the vehicle washing liquid discharge assembly and being operative, when open, to bypass vehicle radar antenna sprayers of the vehicle radar antenna surface. In accordance with another preferred embodiment of the present invention the vehicle also includes a flow restrictor, restricting flow to the vehicle radar antenna sprayers to ensure liquid is supplied to the vehicle windshield sprayers when the normally-open valve is open.

There is further provided in accordance with yet another preferred embodiment of the present invention a liquid heating method including providing a liquid heating enclosure defining a liquid heating volume including a primary liquid heating volume portion and a secondary liquid heating volume portion, separated by a heat-conductive displaceable element and directly heating liquid in the primary liquid heating volume portion, thereby indirectly heating liquid in the secondary liquid heating volume portion via the heat-conductive displacement element.

There is further provided in accordance with still another preferred embodiment of the present invention a vehicle operation method including providing a vehicle including at least one vehicle surface which requires washing and washing the at least one vehicle surface which requires washing by supplying heated liquid from a reservoir as a spray of heated liquid onto the at least one surface which requires washing including causing liquid from the reservoir to be directly heated in a primary liquid heating volume portion and to be indirectly heated in a secondary liquid heating volume portion via a heat-conductive element separating the primary and secondary liquid heating volume portions.

There is yet further provided in accordance with still another preferred embodiment of the present invention a vehicle operation method including providing a vehicle including at least one vehicle surface which requires washing and washing the at

least one vehicle surface which requires washing by at least one of supplying heated liquid from a liquid reservoir via a liquid heating assembly as a spray of heated liquid onto the at least one surface which requires washing and supplying unheated liquid from the liquid reservoir via a normally closed automatically operative valve which, when  
5 open, bypasses the liquid heating assembly.

In accordance with another preferred embodiment of the present invention a vehicle pump connects upstream of the liquid reservoir and downstream of the normally closed automatically operative valve.

In accordance with another preferred embodiment of the present  
10 invention the vehicle operation method also includes providing a vehicle including the at least one vehicle surface which requires washing and washing the at least one vehicle surface which requires washing by supplying heated liquid from the liquid reservoir as a spray of heated liquid onto the at least one surface which requires washing including causing liquid from the liquid reservoir to be directly heated in a primary liquid heating  
15 volume portion and to be indirectly heated in a secondary liquid heating volume portion via a heat-conductive element separating the primary and secondary liquid heating volume portions.

In accordance with another preferred embodiment of the present invention the primary and secondary liquid heating volume portions are defined by a  
20 liquid heating enclosure and the primary liquid heating volume portion includes a heat exchanger for directly heating the liquid in the primary liquid heating volume portion and for indirectly heating the liquid in the secondary liquid heating volume portion via the heat-conductive displacement element.

In accordance with still another preferred embodiment of the present  
25 invention the heat-conductive displaceable element is resiliently and flexibly displaceable. Additionally or alternatively, the heat-conductive displaceable element separates the primary liquid heating volume portion and the secondary liquid heating volume portion. In accordance with still another preferred embodiment of the present invention the liquid flows into a primary liquid flow pathway in the primary liquid  
30 heating volume portion from a secondary liquid flow pathway in the secondary liquid heating volume portion. Additionally or alternatively, at least the liquid flows in at least partially turbulent flow primary liquid flow through the primary liquid heating volume

portion following flowing in at least partially turbulent flow secondary liquid flow through the secondary liquid heating volume portion.

5 In accordance with yet another preferred embodiment of the present invention the liquid flows via an aperture formed in the heat-conductive displaceable element to permit liquid communication from the secondary liquid heating volume portion to the primary liquid heating volume portion.

10 In accordance with another preferred embodiment of the present invention at least one displaceable outer wall portion of the secondary liquid heating volume portion is displaced into the secondary liquid heating volume portion upon freezing of liquid inside the primary liquid heating volume portion.

15 In accordance with another preferred embodiment of the present invention the washing includes an initial spray cycle. Additionally, the indirectly heating liquid in the secondary liquid heating volume portion during a relatively long time duration after initial operation of a motor of the vehicle causes the initial spray cycle to be relatively longer than when the indirectly heating liquid in the secondary liquid heating volume portion is during a relatively short time duration after initial operation of the motor of the vehicle. Additionally, the supplying heated liquid onto the at least one surface is nearly instantaneous when the indirectly heating liquid in the secondary liquid heating volume portion is for a relatively long time duration after the  
20 initial operation of the motor of the vehicle.

25 There is also provided in accordance with another preferred embodiment of the present invention a heated liquid discharge system including a main assembly which provides liquid heating and includes electrical and liquid flow control functionalities, a liquid inflow conduit supplying liquid from a liquid reservoir to the main assembly and a liquid outflow conduit supplying liquid to at least one sprayer located at at least one location on a motor vehicle, the main assembly including a liquid heating chamber communicating with the liquid inflow conduit and the liquid outflow conduit and being formed with a liquid drain aperture located on a side thereof which permits draining of liquid from the liquid heating chamber generally down to a level of  
30 the liquid drain aperture.

In accordance with another preferred embodiment of the present invention the draining takes place when a vehicle pump supplying liquid to the liquid

inflow conduit is not in operation. In accordance with another preferred embodiment of the present invention the at least one location includes at least one of the following locations: front vehicle windshield, back vehicle windshield, side vehicle windows, surface vehicle headlights, vehicle rear lights and vehicle exterior mirrors.

5 In accordance with another preferred embodiment of the present invention a vehicle operator actuation switch is electrically coupled to the main assembly. Additionally or alternatively, the main assembly is connected to a vehicle computer. Alternatively or additionally, the main assembly is connected to a vehicle ignition switch.

10 In accordance with still another preferred embodiment of the present invention the main assembly includes a principal housing portion and a cover housing portion. Additionally, the principal housing portion defines a generally circular cylindrical liquid heating chamber accommodating volume in a major portion of which is disposed a liquid heating assembly including the liquid heating chamber.

15 In accordance with yet another preferred embodiment of the present invention the liquid heating chamber includes a generally circular cylindrical outer sleeve. Additionally, the liquid heating assembly includes a plurality of heating elements located within the liquid heating chamber. In accordance with another preferred embodiment of the present invention electrical characteristics of individual  
20 ones of the plurality of heating elements are different from each other.

In accordance with still another preferred embodiment of the present invention the principal housing portion defines a liquid inlet channel and a heated liquid outlet channel, both communicating with the liquid heating chamber accommodating volume and respectively communicating with the liquid inflow conduit and the liquid  
25 outflow conduit. Additionally, the principal housing portion also defines a heated liquid temperature sensor mounting aperture which communicates with the liquid heating chamber accommodating volume.

In accordance with yet another preferred embodiment of the present invention liquid supplied to the liquid heating chamber accommodating volume via the  
30 liquid inlet channel enters the liquid heating chamber via at least two liquid inlet apertures formed in the liquid heating chamber including a first aperture located near a base of the liquid heating chamber and a second aperture located at an opposite side of

the liquid heating chamber from the first aperture and near a middle of a height of the liquid heating chamber. Additionally, during operation of the vehicle pump supplying liquid to the liquid inflow conduit a level of the liquid exceeds the height of the liquid heating chamber and fills the liquid heating chamber accommodating volume.

5 In accordance with another preferred embodiment of the present invention the liquid drain aperture is located on a side of the liquid heating chamber just below the top thereof, which permits draining of the liquid from the liquid heating chamber accommodating volume generally only down to the level of the liquid drain aperture when the vehicle pump is not in operation. In accordance with still another  
10 preferred embodiment of the present invention the liquid from the liquid reservoir is supplied by the vehicle pump via the liquid inlet conduit via a liquid inlet pathway portion of a liquid connector assembly, which also defines a liquid outlet pathway portion.

In accordance with another preferred embodiment of the present  
15 invention the liquid connector assembly defines a differential pressure bypass pathway portion, which is controlled by a one-way valve and which permits liquid flow from the liquid inlet pathway portion to the liquid outlet pathway portion when a pressure differential thereacross reaches a predetermined threshold, which indicates the existence of a blockage in a liquid path through the liquid heating chamber accommodating  
20 volume. Additionally, the liquid inlet pathway portion includes a leaky one way valve which permits supply of liquid under pressure to the liquid heating chamber accommodating volume but restricts backflow therethrough to a relatively slow rate.

In accordance with a further preferred embodiment of the present  
25 invention the liquid passes through the liquid inlet channel, fills the liquid heating chamber accommodating volume and flows into the liquid heating chamber via the first and second apertures. In accordance with still another preferred embodiment of the present invention the liquid is heated in the liquid heating chamber and a temperature of the liquid or of air overlying the liquid, depending on the liquid level of the liquid, is sensed by at least one temperature sensor. In accordance with another preferred  
30 embodiment of the present invention the at least one temperature sensor is mounted onto a printed circuit board which is mounted within the principal housing portion and located outside of the liquid heating chamber accommodating volume.

In accordance with another preferred embodiment of the present invention the heated liquid discharge system also includes control circuitry, for operation of the main assembly, which is connected to the at least one temperature sensor.

5 In accordance with yet another preferred embodiment of the present invention the heated liquid discharge system also includes an overheating cut-off fuse for shutting off electrical power to at least part of the main assembly in the event of overheating of the liquid heating chamber. In accordance with still another preferred embodiment of the present invention the fuse is formed with an undersurface of a  
10 resilient material and is retained in tight thermal engagement with the underside of a base of the liquid heating element.

In accordance with another preferred embodiment of the present invention the liquid drain aperture together with a leaky one-way valve provides both overheating and anti-freezing protection for the main assembly.

15 In accordance with yet another preferred embodiment of the present invention when the liquid is not being pumped into the liquid heating chamber, the liquid tends to drain slowly from the liquid heating chamber via the leaky one-way valve until a level of liquid in the liquid heating chamber reaches the level of the liquid drain aperture, at which point air, rather than liquid is drawn into the liquid outflow  
20 conduit, effectively terminating drainage and retaining liquid inside the liquid heating chamber accommodating volume generally at the level of the liquid drain aperture.

In accordance with still another preferred embodiment of the present invention retention of liquid inside the liquid heating chamber at a level generally not lower than that of the liquid drain aperture ensures that the level of liquid in the liquid  
25 heating chamber at least covers most of the heating elements located therein, ensuring rapid heating of the liquid and avoiding burning out of the heating elements due to lack of the liquid in the vicinity thereof and retention of the liquid inside the liquid heating chamber at a level no higher than that of the liquid drain aperture ensures that sufficient freezing expansion volume is provided so that when the vehicle is not being operated  
30 and is in a freezing environment, freezing of the liquid therein does not cause cracking of the liquid heating chamber.

There is yet further provided in accordance with yet another preferred embodiment of the present invention a heated liquid discharge system including a main assembly which provides liquid heating and includes electrical and liquid flow control functionalities, a liquid inflow conduit supplying liquid from a liquid reservoir to the main assembly and a liquid outflow conduit supplying liquid to at least one sprayer located at at least one location on a motor vehicle, the liquid inflow conduit having connected in series therewith a leaky one-way valve which permits limited backflow of liquid from the main assembly to the reservoir.

There is even further provided in accordance with yet another preferred embodiment of the present invention a heated liquid discharge system including a main assembly which provides liquid heating and includes electrical and liquid flow control functionalities, a liquid inflow conduit supplying liquid from a liquid reservoir to the main assembly and a liquid outflow conduit supplying liquid to at least one sprayer located at at least one location on a motor vehicle, the main assembly including a liquid heating chamber and an electrical circuit board having mounted thereon a liquid temperature sensor which senses temperature of the liquid in the liquid heating chamber.

In accordance with yet another preferred embodiment of the present invention the main assembly includes a liquid heating chamber communicating with the liquid inflow conduit and the liquid outflow conduit and being formed with a liquid drain aperture located on a side thereof which permits draining of liquid from the liquid heating chamber generally down to level of the liquid drain aperture via the leaky one-way valve.

In accordance with yet another preferred embodiment of the present invention the draining takes place when a vehicle pump supplying liquid to the liquid inflow conduit is not in operation. In accordance with another preferred embodiment of the present invention the at least one location includes at least one of the following locations: front vehicle windshield, back vehicle windshield, side vehicle windows, surface vehicle headlights, vehicle rear lights and vehicle exterior mirrors.

In accordance with still another preferred embodiment of the present invention a vehicle operator actuation switch is electrically coupled to the main assembly. Alternatively or additionally, the main assembly is connected to a vehicle

computer. Additionally or alternatively, the main assembly is connected to a vehicle ignition switch.

5 In accordance with yet another preferred embodiment of the present invention the main assembly includes a principal housing portion and a cover housing portion. Additionally, the principal housing portion defines a generally circular cylindrical liquid heating chamber accommodating volume in a major portion of which is disposed a liquid heating assembly including the liquid heating chamber.

10 In accordance with still another preferred embodiment of the present invention the liquid heating chamber includes a generally circular cylindrical outer sleeve. Preferably, the liquid heating assembly includes a plurality of heating elements located within the liquid heating chamber. Additionally, electrical characteristics of individual ones of the plurality of heating elements are different from each other.

15 In accordance with still another preferred embodiment of the present invention the principal housing portion defines a liquid inlet channel and a heated liquid outlet channel, both communicating with the liquid heating chamber accommodating volume and respectively communicating with the liquid inflow conduit and the liquid outflow conduit. Additionally, the principal housing portion also defines a heated liquid temperature sensor mounting aperture which communicates with the liquid heating chamber accommodating volume. In accordance with yet another preferred embodiment of the present invention liquid supplied to the liquid heating chamber accommodating volume via the liquid inlet channel enters the liquid heating chamber via at least two liquid inlet apertures formed in the liquid heating chamber including a first aperture located near a base of the liquid heating chamber and a second aperture located at an opposite side of the liquid heating chamber from the first aperture and near a middle of a height of the liquid heating chamber.

25 In accordance with yet another preferred embodiment of the present invention during operation of the vehicle pump supplying liquid to the liquid inflow conduit a level of the liquid exceeds the height of the liquid heating chamber and fills the liquid heating chamber accommodating volume. Additionally, the liquid drain aperture is located on a side of the liquid heating chamber just below the top thereof, which permits draining of the liquid from the liquid heating chamber accommodating volume generally only down to the level of the liquid drain aperture when the vehicle

pump is not in operation. In accordance with another preferred embodiment of the present invention the liquid from the liquid reservoir is supplied by the vehicle pump via the liquid inlet conduit via a liquid inlet pathway portion of a liquid connector assembly, which also defines a liquid outlet pathway portion.

5 In accordance with yet another preferred embodiment of the present invention the liquid connector assembly defines a differential pressure bypass pathway portion, which is controlled by a one-way valve and which permits liquid flow from the liquid inlet pathway portion to the liquid outlet pathway portion when a pressure differential thereacross reaches a predetermined threshold, which indicates the existence  
10 of a blockage in a liquid path through the liquid heating chamber accommodating volume. In accordance with yet another preferred embodiment of the present invention the liquid inlet pathway portion includes a leaky one way valve which permits supply of liquid under pressure to the liquid heating chamber accommodating volume but restricts backflow therethrough to a relatively slow rate.

15 In accordance with another preferred embodiment of the present invention the liquid passes through the liquid inlet channel, fills the liquid heating chamber accommodating volume and flows into the liquid heating chamber via the first and second apertures.

20 In accordance with yet another preferred embodiment of the present invention the liquid is heated in the liquid heating chamber and a temperature of the liquid or of air overlying the liquid, depending on the liquid level of the liquid, is sensed by the liquid temperature sensor.

25 In accordance with yet another preferred embodiment of the present invention the at liquid temperature sensor is mounted onto a printed circuit board which is mounted within the principal housing portion and located outside of the liquid heating chamber accommodating volume.

In accordance with yet another preferred embodiment of the present invention the heated liquid discharge system also includes control circuitry, for operation of the main assembly, which is connected to the liquid temperature sensor.

30 In accordance with another preferred embodiment of the present invention the heated liquid discharge system also includes an overheating cut-off fuse for shutting off electrical power to at least part of the main assembly in the event of

overheating of the liquid heating chamber. Preferably, the fuse is formed with an undersurface of a resilient material and is retained in tight thermal engagement with the underside of a base of the liquid heating element.

5 In accordance with another preferred embodiment of the present invention the liquid drain aperture together with the leaky one-way valve provides both overheating and anti-freezing protection for the main assembly.

10 In accordance with yet another preferred embodiment of the present invention when the liquid is not being pumped into the liquid heating chamber, the liquid tends to drain slowly from the liquid heating chamber via the leaky one-way valve until a level of liquid in the liquid heating chamber reaches the level of the liquid drain aperture, at which point air, rather than liquid is drawn into the liquid outflow conduit, effectively terminating drainage and retaining liquid inside the liquid heating chamber accommodating volume generally at the level of the liquid drain aperture.

15 In accordance with still another preferred embodiment of the present invention retention of liquid inside the liquid heating chamber at a level generally not lower than that of the liquid drain aperture ensures that the level of liquid in the liquid heating chamber at least covers most of the heating elements located therein, ensuring rapid heating of the liquid and avoiding burning out of the heating elements due to lack of the liquid in the vicinity thereof and retention of the liquid inside the liquid heating chamber at a level no higher than that of the liquid drain aperture ensures that sufficient freezing expansion volume is provided so that when the vehicle is not being operated and is in a freezing environment, freezing of the liquid therein does not cause cracking of the liquid heating chamber.

25 There is yet further provided in accordance with still another preferred embodiment of the present invention a heated liquid discharge method including supplying liquid from a liquid reservoir to a liquid heating chamber included in a main assembly, heating the liquid in the liquid heating chamber, supplying heated liquid from the liquid heating chamber to at least one sprayer located at at least one location on a motor vehicle and draining of liquid to the liquid reservoir from the liquid heating chamber generally down to a predetermined level in the liquid heating chamber.

30 In accordance with another preferred embodiment of the present invention the supplying liquid from a liquid reservoir to a liquid heating chamber is via

a liquid inflow conduit and the supplying heated liquid from the liquid heating chamber to the at least one sprayer located at at least one location on a motor vehicle is via a liquid outflow conduit. Additionally or alternatively, the draining is via a liquid drain aperture located on a side of the liquid heating chamber. Preferably, the draining takes place when a vehicle pump supplying liquid to the liquid inflow conduit is not in operation.

In accordance with yet another preferred embodiment of the present invention the at least one location includes at least one of the following locations: front vehicle windshield, back vehicle windshield, side vehicle windows, surface vehicle headlights, vehicle rear lights and vehicle exterior mirrors.

In accordance with another preferred embodiment of the present invention the heated liquid discharge method also includes electrically coupling a vehicle operator actuation switch to the main assembly.

In accordance with another preferred embodiment of the present invention the heated liquid discharge method also includes connecting the main assembly to a vehicle computer. In accordance with another preferred embodiment of the present invention the heated liquid discharge method also includes connecting the main assembly to a vehicle ignition switch.

In accordance with another preferred embodiment of the present invention the heating the liquid in the liquid heating chamber is provided by a plurality of heating elements located within the liquid heating chamber. In accordance with another preferred embodiment of the present invention electrical characteristics of individual ones of the plurality of heating elements are different from each other.

In accordance with another preferred embodiment of the present invention the liquid flows to the liquid heating chamber via a liquid inlet channel and enters the liquid heating chamber via at least two liquid inlet apertures formed in the liquid heating chamber including a first aperture located near a base of the liquid heating chamber and a second aperture located at an opposite side of the liquid heating chamber from the first aperture and near a middle of a height of the liquid heating chamber.

In accordance with another preferred embodiment of the present invention during operation of the vehicle pump supplying liquid to the liquid inflow

conduit a level of the liquid exceeds the height of the liquid heating chamber and fills a liquid heating chamber accommodating volume defined within the liquid heating chamber.

5 In accordance with still another preferred embodiment of the present invention the liquid drain aperture is located on a side of the liquid heating chamber just below the top thereof, which permits the draining of the liquid from the liquid heating chamber accommodating volume generally only down to the level of the liquid drain aperture when the vehicle pump is not in operation.

10 In accordance with still another preferred embodiment of the present invention the liquid from the liquid reservoir is supplied by the vehicle pump via the liquid inlet conduit via a liquid inlet pathway portion of a liquid connector assembly, which also defines a liquid outlet pathway portion.

15 In accordance with still another preferred embodiment of the present invention the heated liquid discharge method also includes controlling a differential pressure bypass pathway portion defined within a liquid connector assembly by a one-way valve, the one-way valve permits liquid flow from the liquid inlet pathway portion to the liquid outlet pathway portion when a pressure differential thereacross reaches a predetermined threshold, which indicates the existence of a blockage in a liquid path through the liquid heating chamber accommodating volume.

20 In accordance with yet another preferred embodiment of the present invention the heated liquid discharge method and also includes permitting supply of liquid under pressure to the liquid heating chamber accommodating volume but restricting backflow therethrough to a relatively slow rate.

25 In accordance with another preferred embodiment of the present invention the liquid passes through the liquid inlet channel, fills the liquid heating chamber accommodating volume and flows into the liquid heating chamber via the first and second apertures.

30 In accordance with still another preferred embodiment of the present invention the heated liquid discharge method also includes sensing a temperature of the liquid in the liquid heating chamber or of air overlying the liquid, depending on the liquid level of the liquid, by at least one temperature sensor.

In accordance with still another preferred embodiment of the present invention the heated liquid discharge method also includes operating the main assembly by a control circuitry, for operation of the main assembly, which is connected to the at least one temperature sensor.

5 In accordance with still another preferred embodiment of the present invention the heated liquid discharge method also includes shutting off electrical power to at least part of the main assembly in the event of overheating of the liquid heating chamber by an overheating cut-off fuse. Preferably, the fuse is formed with an undersurface of a resilient material and is retained in tight thermal engagement with the  
10 underside of a base of the liquid heating element.

In accordance with yet another preferred embodiment of the present invention the heated liquid discharge method also includes providing both overheating and anti-freezing protection for the main assembly by the liquid drain aperture together with a leaky one-way valve.

15 In accordance with still another preferred embodiment of the present invention when the liquid is not being pumped into the liquid heating chamber, the liquid tends to drain slowly from the liquid heating chamber via the leaky one-way valve until a level of liquid in the liquid heating chamber reaches a level of the liquid drain aperture, at which point air, rather than liquid is drawn into the liquid outflow  
20 conduit, effectively terminating drainage and retaining liquid inside the liquid heating chamber accommodating volume generally at the level of the liquid drain aperture.

In accordance with still another preferred embodiment of the present invention retention of liquid inside the liquid heating chamber at a level generally not lower than that of the liquid drain aperture ensures that the level of liquid in the liquid  
25 heating chamber at least covers most of the heating elements located therein, ensuring rapid heating of the liquid and avoiding burning out of the heating elements due to lack of the liquid in the vicinity thereof and retention of the liquid inside the liquid heating chamber at a level no higher than that of the liquid drain aperture ensures that sufficient freezing expansion volume is provided so that when the vehicle is not being operated  
30 and is in a freezing environment, freezing of the liquid therein does not cause cracking of the liquid heating chamber.

There is also provided in accordance with still another preferred embodiment of the present invention a heated liquid discharge method including supplying liquid from a liquid reservoir to a liquid heating chamber, heating the liquid in the liquid heating chamber, supplying heated liquid from the liquid heating chamber to at least one sprayer located at at least one location on a motor vehicle and draining of liquid to the liquid reservoir from the liquid heating chamber via a leaky one-way valve.

There is further provided in accordance with yet another preferred embodiment of the present invention a heated liquid discharge method including supplying liquid from a liquid reservoir to a liquid heating chamber, heating the liquid in the liquid heating chamber, supplying heated liquid from the liquid heating chamber to at least one sprayer located at at least one location on a motor vehicle, sensing a temperature of the heated liquid and separately sensing a temperature of the liquid heating chamber.

362. A heated liquid discharge method according to claim 361 and also including draining of the liquid to the liquid reservoir from the liquid heating chamber generally down to a predetermined level in the liquid heating chamber.

In accordance with another preferred embodiment of the present invention the supplying liquid from a liquid reservoir to a liquid heating chamber is via a liquid inflow conduit and the supplying heated liquid from the liquid heating chamber to the at least one sprayer located at at least one location on a motor vehicle is via a liquid outflow conduit.

## BRIEF DESCRIPTION OF THE DRAWINGS AND APPENDIX

The present invention will be understood and appreciated from the following detailed description, taken in conjunction with the drawings and appendix in which:

Fig. 1 is a simplified partially pictorial and partially schematic illustration of a heated liquid discharge system constructed and operative in accordance with a preferred embodiment of the present invention installed in a motor vehicle;

Figs. 2A and 2B are, respectively, a simplified pictorial illustration and a simplified partially exploded view illustration of an assembly forming part of the system of Fig. 1;

Fig. 3 is a simplified exploded view illustration of part of the assembly shown in Figs. 2A and 2B;

Fig. 4 is a simplified exploded view illustration of a subassembly of the assembly shown in Figs. 2B and 3;

Fig. 5 is a simplified illustration of one of the elements of the subassembly shown in Fig. 4;

Figs. 6A, 6B and 6C are, respectively, a simplified illustration of another embodiment of some of the elements of the subassembly shown in Fig. 4, a sectional illustration taken along lines VIB - VIB in Fig. 6A and a partial sectional illustration taken along lines VIC - VIC in Fig. 6B;

Fig. 7A and 7B are, respectively, a simplified illustration of another embodiment of some of the elements of the subassembly shown in Fig. 4 and a sectional illustration taken along lines VIIB - VIIB in Fig. 7A;

Fig. 8 is a sectional illustration of the subassembly shown in Fig. 4 in two operative orientations;

Fig. 9A and 9B are, respectively, a simplified illustration of another embodiment of the elements shown in Figs. 7A & 7B and a sectional illustration taken along lines IXB - IXB in Fig. 9A;

Fig. 10 is a sectional illustration of another embodiment of the subassembly shown in Fig. 4 and which incorporates the embodiment of Figs. 9A & 9B, in two operative orientations;

5 Fig. 11 is a simplified timing diagram illustrating the operation of the system of Figs. 1 - 10;

Fig. 12 is a simplified partially pictorial and partially schematic illustration of a heated liquid discharge system constructed and operative in accordance with another preferred embodiment of the present invention installed in a motor vehicle;

10 Figs. 13A and 13B are, respectively, a simplified pictorial illustration and a simplified partially exploded view illustration of an assembly forming part of the system of Fig. 12;

Fig. 14 is a simplified exploded view illustration of part of the assembly shown in Figs. 13A and 13B;

15 Fig. 15 is a simplified timing diagram illustrating the operation of the system of Figs. 12 - 14;

Fig. 16 is a simplified partially pictorial and partially schematic illustration of a heated liquid discharge system constructed and operative in accordance with yet another preferred embodiment of the present invention installed in a motor vehicle;

20 Figs. 17A and 17B are, respectively, a simplified pictorial illustration and a simplified partially exploded view illustration of an assembly forming part of the system of Fig. 16;

Fig. 18 is a simplified exploded view illustration of part of the assembly shown in Figs. 17A and 17B;

25 Fig. 19 is a simplified illustration of a heated liquid discharge system constructed and operative in accordance with another preferred embodiment of the present invention mounted in a motor vehicle;

Fig. 20 is a simplified exploded view illustration of a portion of the heated liquid discharge system of Fig. 19;

30 Figs. 21A & 21B are simplified front view and back view pictorial illustrations corresponding to Fig. 20;

Fig. 22 is a simplified sectional illustration taken along lines XXII - XXII in Fig. 21A;

Fig. 23 is a simplified sectional illustration taken along lines XXIII - XXIII in Fig. 21A; and

5 Figs. 24A, 24B, 24C/1, 24C/2, 24C/3, 24D, 24E, 24F, 24G & 24H are together an electrical schematic illustration of the circuitry of the system of Figs. 19 - 23.

#### BRIEF DESCRIPTION OF THE APPENDIX

10 The Appendix includes a computer listing which form a heated liquid discharge system in accordance with a preferred software embodiment of the present invention when installed in accordance with installation instructions set forth hereinbelow.

15

## DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference is now made to Fig. 1, which is a simplified pictorial illustration of a heated liquid discharge system constructed and operative in accordance with a preferred embodiment of the present invention installed in a motor vehicle. As seen in Fig. 1, an otherwise conventional motor vehicle 100 is seen to incorporate a heated liquid discharge system 102 constructed and operative in accordance with a preferred embodiment of the present invention. The heated liquid discharge system preferably includes a vehicle washing liquid discharge assembly, a vehicle surface washer assembly and a main assembly 104, which provides liquid heating as well as electrical and liquid flow control functionalities. Main assembly 104 is electrically connected via electrical cables 106 to a vehicle battery 108. It is appreciated that vehicle washing liquid discharge assembly and vehicle surface washing assembly are preferably a part of conventional motor vehicle 100.

A liquid inflow conduit 110 supplies washing liquid, such as water or windshield cleaning liquid, from a vehicle liquid reservoir 112, having an associated vehicle pump 114, to main assembly 104. Liquid inflow conduit 110 preferably includes first and second branches 116 and 118. Branch 116 is coupled to an output of vehicle pump 114, while branch 118 is coupled directly to the interior of reservoir 112. Thus liquid may be obtained from reservoir 112 independently of whether vehicle pump 114 is in operation. A one-way valve 120 is preferably provided along branch 118, to prevent liquid pumped by vehicle pump 114 from returning to the reservoir 112 via branch 118.

A liquid outflow conduit 122 supplies washing liquid to one or more sprayers 124, which may be located at one or more of the following vehicle surfaces which requires washing: front vehicle windshield, back vehicle windshield, side vehicle windows in general and especially in locations providing viewing access to vehicle exterior mirrors, vehicle headlights, vehicle rear lights and vehicle exterior mirrors.

A vehicle operator actuation switch 130, typically located on the vehicle dashboard, is electrically coupled to main assembly 104 by a control conductor 132. Additional control conductors of any suitable number, here designated by reference

numeral 134, may couple the main assembly 104 to a vehicle computer (not shown) or to individual vehicle components, such as vehicle pump 114 or vehicle windshield wipers 135. One or more sensor conductors, here designated by reference numeral 136, may couple one or more external sensors 137, such as, for example, temperature sensors, vehicle speed sensors and humidity sensors, to the main assembly 104, either directly or via the vehicle computer.

In accordance with a preferred embodiment of the present invention, main assembly 104 may have associated therewith, typically in a subassembly 140, an auxiliary pump 142 in series along the liquid inflow conduit 110. Preferably, a one-way valve equipped bypass conduit 144 is provided in parallel to auxiliary pump 142 for permitting liquid ingress to main assembly 104 along liquid outflow conduit 122, even if auxiliary pump 142 fails to function. A one way valve 146 is arranged along bypass conduit 144 so as to prevent backflow of the output of auxiliary pump 142 in a direction away from main assembly 104.

Additionally, in accordance with a preferred embodiment of the present invention, a normally closed automatically operative valve, which is preferably a differential pressure responsive one-way valve 148 interconnects liquid outflow conduit 122 and liquid inflow conduit 110. Differential pressure responsive one-way valve 148 is opened when a pressure difference thereacross exceeds a predetermined threshold, typically 0.3 - 0.5 bar, so as to enable normal operation of vehicle sprayers 124 in response to conventional vehicle actuation of vehicle pump 114, notwithstanding malfunction of the main assembly 104.

Reference is now made to Figs. 2A and 2B, which are, respectively, a simplified pictorial illustration and a simplified partially exploded view illustration of the main assembly 104, forming part of the system of Fig. 1. As seen in Fig. 2A, the main assembly 104 preferably comprises a housing 200, including a base 202 and a cover 204, which are preferably mounted onto vehicle 100 (Fig. 1) by means of a mounting bracket 206.

As seen with greater particularity in Fig. 2B, the main assembly 104 comprises a liquid heating subassembly 208, which preferably includes a heat exchanger preferably in the form of a primary liquid heating volume portion and a secondary liquid heating volume portion. Primary liquid heating volume portion and

secondary liquid heating volume portion are preferably in the form of first and second conduit elements 210 and 212, which are preferably bolted together. First and second conduit elements 210 and 212 define a liquid heating enclosure which an interior thereof defines a liquid heating volume. Preferably, mounted onto liquid heating subassembly 208 there is provided an electrical control subassembly 214, typically comprising an electrical circuit board 216 and a plurality of heating elements, preferably three in number, designated by reference numerals 218, 220 and 222. An electrical connector 224, of conventional construction, provides electrical connections for control conductors 132 & 134 and sensor conductor 136, which are preferably connected to pads on circuit board 216. Cables 106, which provide connection to the vehicle battery 108 (Fig. 1), typically are coupled directly to the circuit board 216. A liquid temperature sensor 226, which senses the temperature of liquid as it leaves the liquid heating subassembly 208, is also coupled directly to the circuit board 216.

Electrical circuitry on electrical circuit board 216 provides, inter alia, control of the operation of liquid heating elements 218, 220 and 222, preferably by means of first and second relays 228 and 230 and a FET 232 (Field-Effect Transistor), respectively.

Communicating with first and second conduit elements 210 and 212 and with respective liquid outflow conduit 122 and liquid inflow conduit 110 are liquid outflow and liquid inflow connectors 240 and 242 respectively, which are seen to be interconnected by differential pressure responsive one-way valve 148. Auxiliary pump 142, bypass conduit 144 and one-way valve 146 are seen disposed in liquid inflow connector 242, it being appreciated that alternatively they may be located externally thereof.

Reference is now made to Fig. 3, which is a simplified exploded view illustration the of part of the assembly shown in Figs. 2A & 2B, to Fig. 4, which is a simplified exploded view illustration of the liquid heating subassembly 208 shown in Figs. 2B and 3 and to Fig. 5, which is a simplified illustration of one of the elements of the liquid heating subassembly 208 shown in Fig. 4.

As seen in Fig. 3, relays 228 and 230 and FET 232, as well as other electrical components (not shown), are typically mounted onto printed circuit board 216, which is, in turn, mounted onto first conduit element 210, preferably by means of

screws 234 and spacers 236. First conduit element 210 is preferably formed of a good conductor, such as aluminum, and has mounted thereon, in heat exchange relationship, the three heating elements 218, 220 and 222, preferably by means of screws 238.

5 Second conduit element 212 is preferably formed of a somewhat flexible and resilient material, such as LEXAN®, and is preferably sealed as by screws 240 to 210 and to a heat-conductive displaceable element, which is preferably an intervening liquid impermeable diaphragm 250. The diaphragm may be an element separate from the second conduit element, as shown in Figs. 3, 4, 6A, 6B, 7A, 7B & 8, or alternatively may be integrally formed with the second conduit element, as illustrated in Figs. 9A, 9B  
10 and 10 and described hereinbelow. Fig. 4 illustrates typical general configurations of conduits defined by first and second conduit elements 210 and 212 extending from a liquid ingress opening 252 in second conduit element 212, via a conduit 254 defined therein and via one or more apertures 256 formed in diaphragm 250, through a conduit 258 formed in first conduit element 210 and out through a heated liquid egress opening  
15 260 formed in the first conduit element 210.

It is a particular feature of the embodiment of Fig. 5 that the conduit 258 defined by the first conduit element 210 includes a plurality of bifurcated conduit portions, including straight bifurcated portions 262 and curved bifurcated portions 264. The function of the bifurcated conduit portions 262 and 264 is to generate turbulence  
20 and generally to help cause the flow of liquid therethrough to be such that generally all of the liquid flowing through the first conduit element 210 is in heat exchange contact with the walls of the conduit 258 to generally the same extent. For example, the provision of bifurcated conduit portions 262 and 264 prevents the occurrence of a situation where a portion of the liquid is generally in contact with the walls of the  
25 conduit 258 while another portion thereof is generally not in contact with the walls of the conduit 258. The provision of bifurcated conduit portions is intended to enhance the speed and uniformity of liquid heating.

It is noted that conduit 258 may be configured to have side walls having a wavy configuration so as to further enhance the speed and uniformity of liquid  
30 heating.

Reference is now made to Fig. 6A, 6B and 6C, which are, respectively, a simplified illustration of another embodiment of some of the elements of the

subassembly shown in Fig. 4, a sectional illustration taken along lines VIB - VIB in Fig. 6A and a sectional illustration taken along lines VIC - VIC in Fig. 6B. Similarly to that seen in Fig. 5, a conduit 265 defined by a first conduit element 266 includes a plurality of bifurcated conduit portions, including straight bifurcated portions 267 and curved bifurcated portions 268. The function of the bifurcated conduit portions 267 and 268 is to generate turbulence and generally to help cause the flow of liquid therethrough to be such that generally all of the liquid flowing through the first conduit element 266 is in heat exchange contact with the walls of the conduit 265 to generally the same extent.

In the embodiment of Figs. 6A, 6B & 6C, a top conduit wall 269 defined by first conduit element 266 and a bottom conduit wall 270, defined by a diaphragm 271, are configured to have a wavy, toothed or otherwise non-smooth configuration to further help cause the flow of liquid therethrough to be turbulent and such that generally all of the liquid flowing through the first conduit element 266 is in heat exchange contact with the walls of the conduit 265 to generally the same extent. Thus, a situation where a portion of the liquid is generally in contact with the walls of the conduit 265 while another portion thereof is generally not in contact with the walls of the conduit 265 is substantially obviated and the speed and uniformity of liquid heating is correspondingly enhanced.

It is noted that conduit 265 may be additionally configured to have side walls having a wavy configuration so as to further enhance the speed and uniformity of liquid heating.

Reference is now made to Fig. 7A, which is a simplified illustration of one embodiment of the second conduit element 212 shown in Figs. 2A - 5, to Fig. 7B, which is a sectional illustration taken along lines VIIB - VIIB in Fig. 7A, and to Fig. 8, which is a sectional illustration of Fig. 4 in two operative orientations. Figs. 7A and 7B illustrate a relatively resilient and flexible second conduit element 212 in association with resilient and flexible diaphragm 250. Liquid entering second conduit element 212 at liquid ingress opening 252 travels along a labyrinthine path defined by relatively rigid baffles 272 between a relatively flexible and resilient base 274, preferably integrally formed with baffles 272 and diaphragm 250. The liquid exits the second conduit element 212 via one or more apertures 256 formed in diaphragm 250.

As illustrated particularly in Fig. 8, the provision of second conduit element 212 provides freezing protection for the liquid heating subassembly 208, such that, when liquid freezes in the first conduit element 210, its expansion causes diaphragm 250 to bow outwardly from first conduit element 210 and to expand into the volume of second conduit element 212. Accordingly, expansion of the liquid in first conduit element 210 is accommodated without producing possible cracking or other damage to the first conduit element 210. Freezing of the liquid in the second conduit element 212 and displacement of the diaphragm 250 into the volume of the second conduit element is accommodated by outward bowing of the resilient base 274.

The structure of the liquid heating subassembly 208 as described hereinabove, including a first conduit element 210, having heating elements directed associated therewith, and a second conduit element 212, not having heating elements directly associated therewith, but nevertheless being in a relatively slow heat exchange relationship with the first conduit element 210, also has the advantage of providing a limited pre-heating functionality for liquid supplied from reservoir 112 (Fig. 1), first to the second conduit element 212 and therefrom to the first conduit element 210.

It is noted that second conduit element 212 may be provided with heating elements (not shown).

Reference is now made to Fig. 9A, which is a simplified illustration of an alternative to the embodiment of the second conduit element 212 shown in Figs. 2A - 5, to Fig. 9B, which is a sectional illustration taken along lines IXB - IXB in Fig. 9A, and to Fig. 10, which is a sectional illustration of another embodiment of the subassembly shown in Fig. 4 and which incorporates the embodiment of Figs. 9A & 9B, in two operative orientations. Figs. 9A and 9B illustrate a relatively resilient and flexible second conduit element 282, preferably integrally formed with a resilient and flexible diaphragm 284. Liquid entering second conduit element 282 at a liquid ingress opening 286 travels along a labyrinthine path defined by relatively rigid baffles 288 between a relatively flexible and resilient base 290, preferably bonded to baffles 288 and diaphragm 284. The liquid exits the second conduit element 282 via one or more apertures 292 formed in diaphragm 284.

As illustrated particularly in Fig. 10, the provision of second conduit element 282 provides freezing protection for the liquid heating subassembly 208, in

that, when liquid freezes in the first conduit element 210, its expansion causes diaphragm 284 to bow outwardly from first conduit element 210 and to expand into the volume of second conduit element 282. Accordingly, expansion of the liquid in first conduit element 210 is accommodated without producing possible cracking or other damage to the first conduit element 210. Freezing of the liquid in the second conduit element 282 and displacement of the diaphragm 284 into the volume of the second conduit element 282 preferably is accommodated by outward bowing of the resilient base 290.

The structure of the liquid heating subassembly 208 as described hereinabove, including a first conduit element 210, having heating elements directed associated therewith, and a second conduit element 282, not having heating elements directly associated therewith, but nevertheless being in a relatively slow heat exchange relationship with the first conduit element 210, also has the advantage of providing a limited pre-heating functionality for liquid supplied from reservoir 112 (Fig. 1), first to the second conduit element 282 and therefrom to the first conduit element 210.

Reference is now made to Fig. 11, which is a simplified timing diagram illustrating the operation of the system of Figs. 1 - 10. As seen in Fig. 11, system actuation is preferably initiated by a user, such as the driver of motor vehicle 100 (Fig. 1) pressing an operator actuation switch 130, typically located on the vehicle dashboard, as seen in Fig. 1. It is noted, however, that preferably, at all times that the vehicle is running, even prior to operator actuation of switch 130, FET 232 (Figs. 2B & 3) operates heating element 222 in a continuous manner, so as to maintain liquid within the liquid heating subassembly 208 at a temperature of at least 65 degrees Centigrade, for example. If the ambient temperature at the liquid heating subassembly 208 exceeds the liquid maintenance temperature, FET 232 is preferably caused to terminate or curtail operation of heating element 222 so as to avoid overheating.

Upon user actuation of switch 130, relays 228 and 230 are preferably operated to operate respective heating element 218 and 220, which provide immediate boosted heating of the liquid within first conduit element 210. When sensor 226 senses that the temperature of the liquid within the first conduit element 210 has reached a first predetermined elevated temperature, typically 85 degrees Centigrade, one or both of pumps 114 and 142 are operated to pump heated liquid out from the first conduit

element 210 and to cause the heated liquid to be sprayed by sprayers 124. The operation of one or both of pumps 114 and 142 causes unheated or less heated liquid from reservoir 112 to be supplied initially to second conduit element 212 and thereafter to first conduit element 210 for heating thereof.

5 In the short term, the aforesaid operation of one or both of pumps 114 and 142 causes a drop in the temperature of the liquid as measured by sensor 226. When the temperature of the liquid, as sensed by sensor 226, drops below a predetermined threshold temperature, typically 55 degrees Centigrade, operation of the pumps 114 and 142 is terminated. When further heating again raises the temperature of the liquid,  
10 sensed by sensor 226, to a second predetermined elevated temperature, preferably less than the first predetermined threshold temperature, typically 65 degrees, pump operation is resumed. This intermittent operation of one or both pumps 114 and 142 continues for a predetermined number of cycles or for a predetermined time duration following user actuation of switch 130, typically four cycles.

15 It is noted that the electrical power requirements of the system increase substantially upon user actuation of the switch 130 and remain generally constant until completion of the last cycle following such actuation.

It is additionally noted that the initial spray cycle, designated by reference numeral 300, is typically longer than the subsequent spray cycles, designated  
20 by reference numeral 302, for each user actuation of switch 130. It is further noted that when the user actuation of switch 130 takes place immediately after initiation of operation of FET 232 and heating element 222, such as within 1 - 2 minutes following initial operation of the motor vehicle 100, the initial spray cycle 300, is shorter than the initial spray cycle 304 in a case when the user actuation of switch 130 takes place  
25 significantly later than initial operation of the motor vehicle 100.

It is additionally noted that the time delay between operator actuation of switch 130 and initiation of the initial spray cycle 300 is significantly longer than the time delay between operation actuator of switch 130 and initial spray cycle 304, which is nearly instantaneous. This feature is due partially to the particular structure of the  
30 liquid heating subassembly 208 as described hereinabove, including a first conduit element 210, having heating elements directed associated therewith, and a second conduit element, designated by reference numeral 212 in Figs. 2A - 8 and 282 in Figs.

9A - 10, not having heating elements directly associated therewith, but nevertheless being in a relatively slow heat exchange relationship with the first conduit element 210. Liquid heating subassembly 208 also has the advantage of providing a limited pre-heating functionality for liquid supplied from reservoir 112, first to the second conduit element, designated by reference numeral 212 in Figs. 2A - 8 and 282 in Figs. 9A - 10, and therefrom to the first conduit element 210. The provision of the second conduit element, designated by reference numeral 212 Figs. 2A - 8 and 282 in Figs. 9A - 10, does not significantly adversely affect the speed of providing an initial spray cycle 300 of heated liquid immediately after initial vehicle operation, but does significantly positively affect the speed of providing an initial spray cycle 304 of heated liquid a significant time after initial vehicle operation.

This beneficial functionality results from the fact that diaphragm acts as a good thermal insulator in the short term and prevents significant heat loss from the first conduit element 210 during quick heating of the liquid therein, but allows heat to pass therethrough in the long term, for heating of liquid in both the first and the second conduit elements to the second predetermined temperature even prior to operator actuation of switch 130.

Accordingly, once the vehicle has been running for a significant time, operator actuation of switch 130 produces a nearly instantaneous initial spray cycle 304 of heated liquid and furthermore the quantity of heated liquid which is sprayed is significantly greater, typically up to a factor of 3, than the quantity of heated liquid which is available for spraying immediately following initial vehicle operation.

Reference is now made to Fig. 12, which is a simplified pictorial illustration of a heated liquid discharge system constructed and operative in accordance with a preferred embodiment of the present invention installed in a motor vehicle. As seen in Fig. 12, an otherwise conventional motor vehicle 1100 is seen to incorporate a heated liquid discharge system 1102 constructed and operative in accordance with a preferred embodiment of the present invention. The heated liquid discharge system preferably includes a main assembly 1104, which provides liquid heating as well as electrical and liquid flow control functionalities. Main assembly 1104 is electrically connected via electrical cables 1106 to a vehicle battery 1108.

A liquid inflow conduit 1110 supplies washing liquid, such as water or cleaning liquid, from a vehicle liquid reservoir 1112, having an associated vehicle pump 1114, to main assembly 1104. Liquid inflow conduit 1110 preferably includes first and second branches 1116 and 1118. Branch 1116 is coupled to an output of vehicle pump 1114, while branch 1118 is coupled directly to the interior of reservoir 1112. Thus liquid may be obtained from reservoir 1112 independently of whether vehicle pump 1114 is in operation. A one-way valve 1120 is preferably provided along branch 1118, to prevent liquid pumped by vehicle pump 1114 from returning to the reservoir 1112 via branch 1118.

A liquid outflow conduit 1122 supplies washing liquid to one or more vehicle radar antenna sprayers 1124 operative to discharge liquid onto an external surface of a vehicle radar antenna 1126, typically located between vehicle headlights.

A vehicle radar actuation switch 1130, typically located on the vehicle dashboard, is electrically coupled to main assembly 1104 by a control conductor 1132.

Additional control conductors of any suitable number, here designated by reference numeral 1134, may couple the main assembly 1104 to a vehicle computer (not shown) or to individual vehicle components, such as vehicle pump 1114 or a vehicle radar unit 1135. One or more sensor conductors, here designated by reference numeral 1136, may couple one or more external sensors 1137, such as, for example, temperature sensors, vehicle speed sensors and humidity sensors to the main assembly 1104, either directly or via the vehicle computer. A radar antenna spray control conductor 1138 couples the main assembly 1104 to an automatic gain control circuit (AGC) forming part of the vehicle radar unit 1135.

In accordance with a preferred embodiment of the present invention, main assembly 1104 may include, typically in a subassembly 1140, an auxiliary pump 1142 in series along the liquid inflow conduit 1110. Preferably, a one-way valve equipped bypass conduit 1144 is provided in parallel to auxiliary pump 1142 for permitting liquid ingress to main assembly 1104 along liquid inflow conduit 1110, even if auxiliary pump 1142 fails to function. A one way valve 1146 is arranged along bypass conduit 1144 so as to prevent backflow of the output of auxiliary pump 1142 in a direction away from main assembly 1104.

Additionally, in accordance with a preferred embodiment of the present invention, a differential pressure responsive one-way valve 1148 interconnects liquid outflow conduit 1122 and liquid inflow conduit 1110. Differential pressure responsive one-way valve 1148 is opened when a pressure difference thereacross exceeds a predetermined threshold, typically, 0.3 - 0.5 bar, so as to enable normal operation of vehicle radar antenna sprayers 1124, notwithstanding malfunction of the main assembly 1104.

Reference is now made to Figs. 13A and 13B, which are, respectively, a simplified pictorial illustration and a simplified partially exploded view illustration of the main assembly 1104, forming part of the system of Fig. 12. As seen in Fig. 13A, the main assembly preferably comprises a housing 1200, including a base 1202 and a cover 1204, which are preferably mounted onto vehicle 1100 (Fig. 12) by means of a mounting bracket 1206.

As seen with greater particularity in Fig. 13B, the main assembly 1104 comprises a liquid heating subassembly 1208, which preferably includes first and second conduit elements 1210 and 1212, which are preferably bolted together. Preferably, mounted onto liquid heating subassembly 1208 there is provided an electrical control subassembly 1214, typically comprising an electrical circuit board 1216 and a heating element 1222. An electrical connector 1224, of conventional construction, provides electrical connections for control conductors 1132, 1134 and 1138 and sensor conductor 1136, which are preferably connected to pads on circuit board 1216. Cables 1106, which provide connection to the vehicle battery 1108 (Fig. 12), typically are coupled directly to the circuit board 1216. A liquid temperature sensor 1226, which senses the temperature of liquid as it leaves the liquid heating subassembly 1208, is also coupled directly to the circuit board 1216.

Electrical circuitry on electrical circuit board 1216 provides, inter alia, control of the operation of liquid heating element 1222, preferably by means of a FET 1232.

Communicating with first and second conduit elements 1210 and 1212 and with respective liquid outflow conduit 1122 and liquid inflow conduit 1110 are liquid outflow and liquid inflow connectors 1240 and 1242 respectively, which are seen to be interconnected by differential pressure responsive one-way valve 1148. Auxiliary

pump 1142, bypass conduit 1144 and one-way valve 1146 are seen disposed in liquid inflow connector 1242, it being appreciated that alternatively they may be located externally thereof.

Reference is now made to Fig. 14, which is a simplified exploded view illustration of part of the assembly shown in Figs. 13A & 13B. As seen in Fig. 14, FET 1232 as well as other electrical components (not shown) are typically mounted onto printed circuit board 1216, which is, in turn, mounted onto first conduit element 1210, preferably by means of screws 1234 and spacers 1236. First conduit element 1210 is preferably formed of a good conductor, such as aluminum and has mounted thereon, in heat exchange relationship, heating element 1222 preferably by means of screws 1238.

Second conduit element 1212 is preferably formed of a somewhat flexible and resilient material, such as LEXAN®, and is preferably sealed as by screws 1240 to first conduit element 1210 and to an intervening liquid impermeable diaphragm 1250. Conduits defined by first and second conduit elements 1210 and 1212 extend from a liquid ingress opening 1252 in second conduit element 1212, via a conduit 1254 defined therein and via one or more apertures 1256 formed in diaphragm 1250, through a conduit (not shown) formed in first conduit element 1210 and out through a heated liquid egress opening 1260 formed in the first conduit element 1210.

It is appreciated that the liquid flow in liquid heating subassembly 1208 is identical to the liquid flow described hereinabove in Figs. 5 - 10.

Reference is now made to Fig. 15, which is a simplified timing diagram illustrating the operation of the system of Figs. 12 - 14. As seen in Fig. 15, liquid discharge from vehicle radar antenna sprayers 1124 on vehicle radar antenna 1126 is preferably automatically controlled. When the vehicle is running and when vehicle radar actuation switch 1130 is in an operative orientation (Fig. 12), accumulation of deposits on the vehicle radar antenna 1126, such as slush, mud, rain, and snow cause the AGC to activate the heated liquid discharge system (Figs. 12 - 14) as described hereinbelow.

Preferably, at all times that the vehicle is running, even when the vehicle radar is not activated, FET 1232 (Figs. 13B & 14) operates heating element 1222 in a continuous manner, so as to maintain liquid within the liquid heating subassembly 1208 preferably at a temperature of at least 65 degrees Centigrade, for example. If the ambient temperature at the liquid heating subassembly 1208 exceeds the liquid

maintenance temperature, FET 1232 is preferably caused to terminate or curtail operation of heating element 1222 so as to avoid overheating.

When the AGC provides a signal of at least a predetermined threshold value, here designated by reference numeral 1300, due to accumulations on the vehicle radar antenna 1126, one or both of pumps 1114 and 1142 are operated to pump heated liquid out from the first conduit element 1210 and to cause the heated liquid to be sprayed by vehicle radar antenna sprayers 1124. The operation of one or both of pumps 1114 and 1142 causes unheated or less heated liquid from reservoir 1112 to be supplied initially to second conduit element 1212 and thereafter to first conduit element 1210 for heating thereof. When the value of the AGC output signal drops below another predetermined threshold value, designated by reference numeral 1302, which is typically below threshold value 1300, operation of the pumps 1114 and 1142 is terminated.

In the short term, the operation of one or both of pumps 1114 and 1142 causes a drop in the temperature of the liquid as measured by sensor 1226. When the temperature of the liquid, as sensed by sensor 1226, drops below a predetermined threshold temperature, typically 55 degrees Centigrade, operation of the pumps 1114 and 1142 is terminated. When further heating again raises the temperature of the liquid, sensed by sensor 1226, to a predetermined elevated temperature, typically 65 degrees, pump operation is resumed. This intermittent operation of one or both pumps 1114 and 1142 continues typically until the value of the AGC signal drops below predetermined threshold value 1302.

It is noted that the electrical power requirements of the system increase substantially with increased accumulation and corresponding AGC controlled actuation of the heated liquid discharge system and remain generally constant until completion of the last cycle following such actuation.

It is additionally noted that the initial spray cycle, designated by reference numeral 1310, is typically longer than the subsequent spray cycles, designated by reference numeral 1312, for AGC controlled actuation of the heated liquid discharge system. It is further noted that when AGC controlled actuation of the heated liquid discharge system takes place immediately after initiation of operation of FET 1232 and heating element 1222, such as within 1 - 2 minutes following initial operation of the

motor vehicle 1100, the initial spray cycle 1310, is shorter than the initial spray cycle 1314 in a case when AGC controlled actuation of the heated liquid discharge system takes place significantly later than initial operation of the motor vehicle 1100.

5 It is further noted that the time delay between AGC controlled actuation of the heated liquid discharge system and initiation of the initial spray cycle 1310 is significantly longer than the time delay between AGC controlled actuation of the heated liquid discharge system and initial spray cycle 1314, which is nearly instantaneous. This feature is due partially to the particular structure of the liquid heating subassembly 1208 as described hereinabove, including a first conduit element 1210, having a heating  
10 element 1222 directed associated therewith, and a second conduit element 1212 not having a heating element directly associated therewith, but nevertheless being in a relatively slow heat exchange relationship with the first conduit element 1210.

Liquid heating subassembly 1208 also has the advantage of providing a limited pre-heating functionality for liquid supplied from reservoir 1112, first to the  
15 second conduit element 1212 and therefrom to the first conduit element 1210. The provision of the second conduit element 1212 does not significantly adversely affect the speed of providing an initial spray cycle 1310 of heated liquid immediately after initial vehicle operation, but does significantly positively affect the speed of providing an initial spray cycle 1314 of heated liquid a significant time after initial vehicle operation.

20 This beneficial functionality results from the fact that diaphragm 1250 acts as a good thermal insulator in the short term and prevents significant heat loss from the first conduit element 1210 during quick heating of the liquid therein, but allows heat to pass therethrough in the long term, for heating of liquid in both the first and the second conduit elements to the predetermined elevated temperature even prior to AGC  
25 controlled actuation of the heated liquid discharge system.

Accordingly, once the vehicle has been running for a significant time, operator actuation of vehicle radar actuation switch 1130 produces a nearly instantaneous initial spray cycle 1304 of heated liquid and furthermore the quantity of heated liquid which is sprayed is significantly greater, typically up to a factor of 3, than  
30 the quantity of heated liquid which is available for spraying immediately following initial vehicle operation.

Reference is now made to Fig. 16, which is a simplified pictorial illustration of a heated liquid discharge system constructed and operative in accordance with a preferred embodiment of the present invention installed in a motor vehicle. As seen in Fig. 16, an otherwise conventional motor vehicle 2100 is seen to incorporate a heated liquid discharge system 2102 constructed and operative in accordance with a preferred embodiment of the present invention. The heated liquid discharge system preferably includes a main assembly 2104, which provides liquid heating as well as electrical and liquid flow control functionalities. Main assembly 2104 is electrically connected via electrical cables 2106 to a vehicle battery 2108.

A liquid inflow conduit 2110 supplies washing liquid, such as water or cleaning liquid, from a vehicle liquid reservoir 2112, having an associated vehicle pump 2114, to main assembly 2104. A vehicle computer 2115 governs the operation of the pump 2114 via a control conductor 2116. Liquid inflow conduit 2110 preferably includes first and second branches 2117 and 2118. Branch 2117 is coupled to an output of vehicle pump 2114, while branch 2118 is coupled directly to the interior of reservoir 2112. Thus liquid may be obtained from reservoir 2112 independently of whether vehicle pump 2114 is in operation. A one-way valve 2120 is preferably provided along branch 2118, to prevent liquid pumped by vehicle pump 2114 from returning to the reservoir 2112 via branch 2118.

A liquid outflow conduit 2122 supplies washing liquid to one or more windshield sprayers 2124 operative to discharge liquid onto a vehicle windshield 2126.

In accordance with a preferred embodiment of the present invention, main assembly 2104 may have associated therewith, typically in a subassembly 2130, an auxiliary pump 2132 in series along the liquid inflow conduit 2110. Preferably, a one-way valve equipped bypass conduit 2134 is provided in parallel to auxiliary pump 2132 for permitting liquid ingress to main assembly 2104 along liquid inflow conduit 2110, even if auxiliary pump 2132 fails to function. A one way valve 2136 is arranged along bypass conduit 2134 so as to prevent backflow of the output of auxiliary pump 2132 in a direction away from main assembly 2104.

Additionally, in accordance with a preferred embodiment of the present invention, a differential pressure responsive one-way valve 2138 interconnects liquid outflow conduit 2122 and liquid inflow conduit 2110. Differential pressure responsive

one-way valve 2138 is opened when a pressure difference thereacross exceeds a predetermined threshold, typically, 0.3 - 0.5 bar, so as to enable normal operation of windshield sprayers 2124 and vehicle radar antenna sprayers 2140 in response to conventional vehicle actuation of vehicle pump 2114, notwithstanding malfunction of the main assembly 2104.

A user operated vehicle unheated liquid windshield discharge actuator 2142, typically located in the vicinity of the vehicle steering wheel, is electrically coupled to vehicle computer 2115 by a control conductor 2150. In a first mode of operation, wherein the heated liquid discharge system 2102 is not user actuated for spraying heated liquid onto the radar antenna, operation of user operated vehicle unheated liquid windshield discharge actuator 2142 by a user preferably causes an electrical signal to be transmitted via control conductor 2150 to vehicle computer 2115, which causes activation, by means of control conductor 2116, of vehicle pump 2114. Liquid outflow conduit 2122 supplies liquid from pump 2114 and/or pump 2132 to windshield sprayers 2124 via a conduit branch 2152, a normally-open valve 2154 and a conduit branch 2156. Liquid supplied by vehicle pump 2114 and/or pump 2132 via outflow conduit 2122 is also supplied to windshield sprayers 2124 via a bidirectional valve 2158, a conduit branch 2160 and conduit branch 2156. Bidirectional valve 2158 is normally open for liquid flow from conduit 2122 to conduit branch 2160 and is electrically coupled to main assembly 2104 via control conductor 2161. A one way valve 2162 preferably is provided along conduit branch 2160, so as to prevent flow of liquid away from windshield sprayers 2124.

A user operated heated liquid windshield discharge actuator 2170, typically located on the vehicle dashboard, is electrically coupled to main assembly 2104 via a control conductor 2172. Actuation by a user of user operated heated liquid windshield discharge actuator 2170 causes heated liquid from main assembly 2104 to be supplied via conduit branch 2152, normally-open valve 2154 and conduit branch 2156 as well as via bidirectional valve 2158 to windshield sprayers 2124 via conduit branches 2160 and 2156.

Heated liquid from main assembly 2104 is also supplied to one or more vehicle radar antenna sprayers 2140 in response to an AGC actuation signal received by vehicle computer 2115 from a vehicle radar unit 2173. In response to receipt of the

AGC actuation signal, the vehicle computer 2115 causes main assembly 2104 to provide a direction switch electrical signal along a control conductor 2174 to bidirectional valve 2158, causing it to direct liquid from conduit 2122 along a conduit branch 2176, via a flow restrictor 2178 arranged in series therewith to vehicle radar antenna sprayers 2140. Additionally, in response to receipt of the AGC actuation signal, the vehicle computer 2115 causes main assembly 2104 to provide a valve closing signal to normally open valve 2154 along a control conductor 2182. Alternatively, the AGC actuation signal is supplied directly to the main assembly 2104.

It is appreciated that in a preferred embodiment of the present invention, main assembly 2104 supplies heated liquid to vehicle radar antenna sprayers 2140 only when windshield sprayers 2124 are not

It is a particular feature of the present invention that if during radar antenna spraying operation of the system in response to the AGC actuation signal, either of actuators 2142 and 2170 are actuated by a user, liquid, heated or unheated as the case may be, is immediately directed to windshield sprayers 2124. In the case of actuation of user operated unheated fluid windshield discharge actuator 2142, this is preferably effected by opening of a relay 2184, which is connected in series along control conductor 2182, in response to a relay open signal supplied by vehicle computer 2115 along control conductor 2185, for preventing the valve closing signal from reaching normally open valve 2154, thereby retaining normally open valve 2154 in an open orientation and permitting liquid flow therethrough from conduit 2122 via conduit branch 2152, normally open valve 2154 and conduit branch 2156 to windshield sprayers 2124. In the case of actuation of user operated vehicle heated fluid windshield discharge actuator 2170, this is preferably effected by main assembly 2104 not providing a valve closing signal to normally open valve 2154 along control conductor 2182. Heated liquid from main assembly 2104 is thus supplied to windshield sprayers 2124 as described hereinabove. In both cases the operation of flow restrictor 2178 ensures that liquid reaches windshield sprayers 2124.

A vehicle radar actuation switch 2190, typically located on the vehicle dashboard, is electrically coupled to main assembly 2104 by a control conductor 2192. One or more sensor conductors, here designated by reference numeral 2194, may couple one or more external sensors 2196, such as, for example, temperature sensors, vehicle

speed sensors and humidity sensors to the main assembly 2104, either directly or via the vehicle computer 2115.

5 Reference is now made to Figs. 17A and 17B, which are, respectively, a simplified pictorial illustration and a simplified partially exploded view illustration of the main assembly 2104, forming part of the system of Fig. 16. As seen in Fig. 17A, the main assembly 2104 preferably comprises a housing 2200, including a base 2202 and a cover 2204, which are preferably mounted onto vehicle 2100 (Fig. 16) by means of a mounting bracket 2206.

10 As seen with greater particularity in Fig. 17B, the main assembly 2104 comprises a liquid heating subassembly 2208, which preferably includes first and second conduit elements 2210 and 2212, which are preferably bolted together. Preferably, mounted onto liquid heating subassembly 2208 there is provided an electrical control subassembly 2214, typically comprising an electrical circuit board 2216 and heating elements 2218, 2220 and 2222. An electrical connector 2224, of  
15 conventional construction, provides electrical connections for control conductors 2182, 2161, 2172, and 2194 and sensor conductors 2192, which are preferably connected to pads on circuit board 2216. Cables 2106, which provide connection to the vehicle battery 2108 (Fig. 16), typically are coupled directly to the circuit board 2216. A liquid temperature sensor 2226, which senses the temperature of liquid as it leaves the liquid  
20 heating subassembly 2208, is also coupled directly to the circuit board 2216.

Electrical circuitry on electrical circuit board 2216 provides, inter alia, control of the operation of liquid heating elements 2218, 2220 and 2222, preferably by means of first and second relays 2228 and 2230 and a FET 2232, respectively.

25 Communicating with first and second conduit elements 2210 and 2212 and with respective liquid outflow conduit 2122 and liquid inflow conduit 2110 are liquid outflow and liquid inflow connectors 2240 and 2242 respectively, which are seen to be interconnected by differential valve 2138. Auxiliary pump 2132, bypass conduit 2134 and one-way valve 2136 are seen disposed in liquid inflow connector 2242, it being appreciated that alternatively they may be located externally thereof.

30 Reference is now made to Fig. 18, which is a simplified exploded view illustration of part of the assembly shown in Figs. 17A & 17B. As seen in Fig. 18, relays 2228 and 2230 and FET 2232 as well as other electrical components (not shown) are

typically mounted onto printed circuit board 2216, which is, in turn, mounted onto first conduit element 2210, preferably by means of screws 2234 and spacers 2236. First conduit element 2210 is preferably formed of a good conductor, such as aluminum and has mounted thereon, in heat exchange relationship, the three heating elements 2218, 2220 and 2222 preferably by means of screws 2238.

Second conduit element 2212 is preferably formed of a somewhat flexible and resilient material, such as LEXAN®, and is preferably sealed as by screws 2240 to first conduit element 2210 and to an intervening liquid impermeable diaphragm 2250. Conduits defined by first and second conduit elements 2210 and 2212 extend from a liquid ingress opening 2252 in second conduit element 2212, via a conduit 2254 defined therein and via one or more apertures 2256 formed in diaphragm 2250, through a conduit (not shown) formed in first conduit element 2210 and out through a heated liquid egress opening 2260 formed in the first conduit element 2210.

It is appreciated that the liquid flow in liquid heating subassembly 2208 is identical to the liquid flow described hereinabove in Figs. 5 – 10.

Reference is now made to Fig. 19, which is a simplified illustration of a heated liquid discharge system constructed and operative in accordance with another preferred embodiment of the present invention mounted in a motor vehicle. As seen in Fig. 19, an otherwise conventional motor vehicle 3100 is seen to incorporate a heated liquid discharge system 3102 constructed and operative in accordance with a preferred embodiment of the present invention. The heated liquid discharge system preferably includes a main assembly 3104, which provides liquid heating as well as electrical and liquid flow control functionalities. Main assembly 3104 is electrically connected via electrical cables 3106 and 3107 to a vehicle battery 3108.

A liquid inflow conduit 3110 supplies liquid, such as water or windshield cleaning liquid, from a vehicle liquid reservoir 3112, having an associated vehicle pump 3114, to main assembly 3104.

A liquid outflow conduit 3122 supplies liquid to one or more sprayers 3124, which may be located at one or more of the following vehicle locations: front vehicle windshield, back vehicle windshield, side vehicle windows in general and especially in locations providing viewing access to vehicle exterior mirrors, vehicle headlights, vehicle rear lights and vehicle exterior mirrors.

5 A vehicle operator actuation switch 3130, typically located on the vehicle dashboard, is electrically coupled to main assembly 3104 by a control conductor pair 3132. A pair of vehicle computer interface conductors 3134 and 3136 interconnect the main assembly 3104 to the existing vehicle computer 3138. An ignition interface conductor 3140 interconnects the main assembly 3104 to the existing vehicle ignition switch.

10 Reference is now made additionally to Figs. 20, 21A, 21B, 22 and 23, which illustrate details of the structure and mounting of main assembly 3104. The main assembly 3104 is preferably mounted onto the vehicle chassis by a suitable mounting bracket, such as mounting bracket 3142. Mounting bracket 3142 preferably comprises suitably apertured chassis mounting portions 3144 and 3146 and a slide and snap fit main assembly support portion 3148 having slidable engagement indents 3150 and a snap fit engagement protrusion 3152 having indents 3154. The snap fit engagement protrusion 3152 may be injection molded of plastic directly onto the remainder of  
15 mounting bracket 3142.

Main assembly 3104 comprises a liquid heating chamber communicating with liquid inflow conduit 3122 and liquid outflow conduit 3110 a principal housing portion 3160, which is configured for removable snap-fit engagement therewith by a cover housing portion 3162. As seen particularly in Fig. 21B, the back surface of principal housing portion 3160 is formed with suitably undercut retaining protrusions 3164 which slidably engage corresponding corners 3166 of support portion 3148 underlying indents 3150. As seen particularly in Fig. 21A, the top surface of principal housing portion 3160 is formed with a pair of engagement guides 3168 and inclined snap fit engagement protrusions 3170 which engage indents 3154 in snap fit engagement protrusion 3152.  
20  
25

Principal housing portion 3160 defines a generally circular cylindrical liquid heating chamber accommodating volume 3180, in a major portion of which is disposed a liquid heating assembly 3182. Liquid heating assembly 3182 preferably comprises a circular cylindrical outer sleeve 3184 having a base 3186, which defines a sealing ring retaining socket 3188, arranged to retain an insulative liquid sealing ring 3190.  
30

A plurality of folded over heating elements, preferably three in number, designated by reference numerals 3192, 3194 and 3196, are located within sleeve 3184. Preferably heating elements 3192 and 3194 partially overlie heating element 3196, as seen in Fig. 23. Each of the folded over heating elements 3192, 3194 and 3196 preferably includes a resistance heating element 3198, located within a heating element conductive sleeve 3200 and electrically insulated therefrom by an insulator 3202, such as a ceramic material.

The resistance heating element 3198 is preferably coupled at one end thereof to an electrical connection terminal 3204 extending outwardly of base 3186 and is coupled at an opposite end thereof to conductive sleeve 3200. The conductive sleeves 3200 of each of the folded over heating elements 3192, 3194 and 3196 are electrically coupled to ground via base 3186 and an electrical connector 3206. It is appreciated that the electrical characteristics of the resistance heating elements 3198 of the various folded over heating elements 3192, 3194 and 3196 are typically different from each other.

Principal housing portion 3160 also defines a liquid inlet channel 3210 and a heated liquid outlet channel 3212, both communicating with liquid heating chamber accommodating volume 3180, as well as a heated liquid temperature sensor mounting aperture 3214, also communicating with liquid heating chamber accommodating volume 3180. Liquid supplied to liquid heating chamber accommodating volume 3180 via liquid inlet channel 3210 preferably enters a liquid heating chamber 3216, defined by the interior of sleeve 3184, via at least two liquid inlet apertures formed in sleeve 3184, preferably a first aperture 3218 located near the base 3186 and a second aperture 3220, preferably located at an opposite side of sleeve 3184 and near the middle of the height of the sleeve 3184.

Normally, during operation of pump 3114 (Fig. 19), the level of the liquid exceeds the height of the liquid heating chamber and fills the liquid heating chamber accommodating volume 3180. A liquid drain aperture 3228 is located on a side of sleeve 3184 just below the top thereof, which permits draining of liquid from volume 3180 only down to the level of liquid drain aperture 3228, when the vehicle pump 3114 (Fig. 19) is not in operation. The importance of liquid drain aperture 3228 and its

placement in the liquid heating chamber accommodating volume 3180 will be described hereinbelow.

Liquid from reservoir 3112 (Fig. 19) is supplied by vehicle pump 3114 via liquid inlet conduit 3110 via a liquid inlet pathway portion 3250 of a liquid connector assembly 3252, which also defines a liquid outlet pathway portion 3254. Liquid connector assembly 3252 preferably comprises an injection molded element which also defines a differential pressure bypass pathway portion 3256, which is controlled by a spring loaded one-way valve 3258 and which permits liquid flow from liquid inlet pathway portion 3250 to liquid outlet pathway portion 3254 when the pressure differential thereacross reaches a predetermined threshold, typically 0.3 - 0.5 bar, which indicates the existence of a blockage in the liquid path through valve 3260 and the liquid heating chamber accommodating volume 3180.

Liquid inlet pathway portion 3250 preferably comprises a leaky one way valve 3260, preferably having a channel 3262 formed in a valve seat 3264 thereof, as shown in detail in Fig. 22. Valve 3260 preferably permits supply of liquid under pressure to the liquid heating chamber accommodating volume 3180 but restricts backflow therethrough to a relatively slow rate. The liquid passes through liquid inlet channel 3210 and fills the liquid heating chamber accommodating volume 3180. The liquid flows into liquid heating chamber 3216 via first and second apertures 3218 and 3220 in sleeve 3184.

The liquid is heated in liquid heating chamber 3216 and the temperature of the liquid or the air overlying the liquid, depending on the liquid level, is sensed by a temperature sensor 3270, commercially available from EPCOS AG. Corporate Communications of Munich, Germany, identified by Catalog No. G560/50K/F2 and located in heated liquid temperature sensor mounting aperture 3214. Temperature sensor 3270 preferably is mounted onto a printed circuit board 3272 which is mounted within principal housing portion 3160 and located outside of liquid heating chamber accommodating volume 3180.

Mounted on printed circuit board 3272 is control circuitry for operation of the main assembly 3104 which is connected inter alia to temperature sensor 3270 and via a connector 3274 and a wire harness 3276 including a connector 3278 to control conductor pair 3132, vehicle computer interface conductors 3134 and 3136 and ignition

interface conductor 3140 (Fig. 19). Electrical cables 3106 and 3107 connect the vehicle battery 3108 (Fig. 19) to connection terminals 3280 of a plurality of relays 3282, which supply electrical power to electrical connection terminals 3204 of heating elements 3192, 3194 and 3196 via electrical connectors 3284. Relays 3282 are commercially  
5 available from TYH Enterprise Limited of Tsuen Wan, N.T., Hong Kong. Electrical connector 3206 provides a direct ground connection between base 3186 and the vehicle ground via one of electrical cables 3106 and 3107. An overheating cut-off fuse 3290 is also mounted onto printed circuit board 3272 and is connected to the control circuitry for shutting off power to the heating elements 3192, 3194 and 3196 in the event of  
10 overheating of the liquid heating assembly 3182. Fuse 3290 is preferably formed with an undersurface of a resilient material and is preferably retained in tight thermal engagement with the underside of base 3186 by a cover element 3292.

It is a particular feature of the present invention that the provision of liquid drain aperture 3228 in sleeve 3184 together with leaky one-way valve 3260  
15 provides both overheating and anti-freezing protection for the main assembly 3104. This synergetic functionality may be understood by considering the operation of the system following completion of a spray cycle. At this time, due to deactivation of pump 3114, liquid is not being pumped into liquid heating chamber accommodating volume 3180 and the liquid tends to drain slowly from volume 3180 via channel 3262, leaky one-way  
20 valve 3260, liquid inlet pathway portion 3250, liquid inlet conduit 3110 and vehicle pump 3114 to reservoir 3112. Such drainage continues until the level of liquid in liquid heating chamber accommodating volume 3180 reaches the level of liquid drain aperture 3228, at which point air, rather than liquid is drawn into channel 3262, effectively terminating drainage and retaining liquid inside liquid heating chamber accommodating  
25 volume 3180 at the level of liquid drain aperture 3228.

Retention of liquid inside liquid heating chamber accommodating volume 3180 at a level preferably not lower than that of liquid drain aperture 3228 ensures that the level of liquid in liquid heating chamber 3216 at least covers most of the heating elements 3192, 3194 and 3196, ensuring rapid heating of the liquid at the  
30 next heating cycle and avoiding burning out of the heating elements due to lack of liquid in the vicinity thereof. At the same time retention of liquid inside liquid heating chamber accommodating volume 3180 at a level preferably no higher than that of liquid

drain aperture 3228 ensures that sufficient freezing expansion volume is provided within volume 3180 and within the liquid heating chamber 3216 so that when the vehicle is not being operated and is in a freezing environment, freezing of the liquid therein does not cause cracking of the liquid heating chamber 3216 or of the liquid heating chamber accommodating volume 3180.

Reference is now made to Figs. 24A, 24B, 24C/1, 24C/2, 24C/3, 24D, 24E, 24F, 24G & 24H, which are together a self-explanatory electrical schematic illustration of the circuitry incorporated on PCB 3272 of the system of Figs. 19 - 23. Figs. 24A, 24B, 24C/1, 24C/2, 24C/3, 24D, 24E, 24F, 24G & 24H indicate interconnections of the circuitry on PCB 3272 with various elements of the system of Figs. 19 - 23, whose reference numbers are indicated in parenthesis in Figs. 24A - 24H. The circuitry of Figs. 24A - 24H operates preferably using software contained in the Appendix. Table I contains a list of parts used in the circuitry shown in Figs. 24A-24H.

TABLE I

Reference Designator(s)	Part	Manufacturer	Part Number	PCB Footprint
C1, C2, C4, C12, C24, C26, C29, C30	0.01uF, 100V	AVX Corp., SC, USA	06031C103MAT4A	0603
C3, C7, C10, C15, C19, C22	0.1uF, 100V	AVX Corp., SC, USA	12061C104MAT4A	1206
C6, C9, C16, C20, C21, C23, C25, C27, C28	1000pF, 100V	AVX Corp., SC, USA	06031C102MAT4A	0603
C8, C13, C14, C17, C18, C31, C32	0.1uF, 10V	AVX Corp., SC, USA	0603ZC104MAT4A	0603
C5A, C5B, C11	1uF, 10V	AVX Corp., SC, USA	0805ZC106KAT4A	0805

Reference Designator(s)	Part	Manufacturer	Part Number	PCB Footprint
C33	10uF, 35V	KEMET Electronics, Simpsonville, SC	T491C106M035AS	"C package" or 6032
D1, D3, D6	Fast Switching Rectifier	Diodes Inc., Westlake Village, CA, USA	RS1D	SMA
D9, D12	General Purpose Rectifier	Diodes Inc., Westlake Village, CA, USA	S1D	SMA
D5, D7, D13, D14, D17	Schottky Barrier Diode	Semiconductor Corp., Santa Clara, CA. USA	MBR0540	SOD123
D2, D4, D15, D16	15V, 500mW, Zener	Semiconductor Corp., Santa Clara, CA. USA	MMSZ5245BT1	SOD123
D8, D18	5.1V, 500mW, Zener	Semiconductor Corp., Santa Clara, CA. USA	MMSZ5231BT1	SOD123
D19, D20	DUAL SWITCHING DIODE	Semiconductor Corp., Santa Clara, CA. USA	BAV99LT1	SOT-23
FU1	Thermal Cut Off 140C	Thermtrol Corp., North Canton, OH, USA	N6	THRU
JP1	5 Pin Locking Connector	Molex Inc. Downers Grove, IL, USA	MOLEX043650- 0527	MOLEX043 650-0527
JP2	8 Pin Header	Molex Inc. Downers Grove, IL, USA	10-89-1081	THRU

Reference Designator(s)	Part	Manufacturer	Part Number	PCB Footprint
K1	RELAY	TYH Enterprise Limited, N.T., Hong Kong	HG4520-012-H1S	RELAY-HG4520
K2	RELAY	TYH Enterprise Limited, N.T., Hong Kong	HG4119-012-1H11-1A	RELAY-HG4119
L1, L2	Ferrite Bead, 600ohm @ 100MHz	Murata Manufacturing Co., Ltd., Nagaokakyo-shi, Kyoto	BLM21AG102SN1B	0805
Q1, Q2	P Channel MOSFET, 100V	International Rectifier, El Segundo, CA, USA	IRFL9110	SOT-223
Q3, Q6, Q7	NPN Darlington, 100V	Zetex plc, Oldham, UK	FMMT614	SOT-23
Q4, Q5	Protected N Channel MOSFET	STMicroelectronics, East Bell Road, AZ, USA	VNN1NV0413TR	SOT-223
N1	Temperature Sensor	EPCOS AG. Corporate Communications, Munich, Germany	G560/50K/F2	THRU
N2	Temperature Sensor	EPCOS AG. Corporate Communications, Munich, Germany	G560/50K/F2	THRU

Reference Designator(s)	Part	Manufacturer	Part Number	PCB Footprint
R11	0 OHM	KOA Speer Electronics Inc., Bradford, PA, USA	RM73Z1JLTDD	0603
R25	1.5k, 5%, 500mW	KOA Speer Electronics Inc., Bradford, PA, USA	RK73B2ELTDD152J	1210
R1,R5,R6,R9, R14,R18,R20, R21,R22,R27, R28	10k, 1%	KOA Speer Electronics Inc., Bradford, PA, USA	RK73GC1JLTD1002 F	0603
R7,R10,R12, R13,R15,R19, R23,R24	100k, 1%	KOA Speer Electronics Inc., Bradford, PA, USA	RK73GC1JLTD1003 F	0603
R2, R4, R8	3.3k, 5%, 500mW	KOA Speer Electronics Inc., Bradford, PA, USA	RK73B2ELTDD332J	1210
R3, R16, R17	33.2k, 1%	KOA Speer Electronics Inc., Bradford, PA, USA	RK73GC1JLTD3322 F	0603
U1	8 BIT Micro-controller	Motorola Inc.	MC68HC908KX8M DW	SOIC 16
U2	5V protected regulator	Micrel Semiconductor, Inc. San Jose, CA, USA	MIC2951-02BM	SOIC 8

The Appendix is a software listing of the following computer file:

Appendix containing file HOTSHOT2.S19 and of length 5,434 bytes.

- 5 To program the FLASH memory on the Motorola 68HC908 microcontroller that resides inside the Hotshot product the following steps need to be

conducted:

1). Provide a Personal Computer, such as an Intel-based Pentium III 800 MHz computer, 256 MB RAM and 2 GB Hard Disk configured with Microsoft Windows 2000 operating system.

5 2). Start the Prog08SZ.exe programmer for Windows version 1.38 provided from P&E Microcomputers System Inc, PO Box 2044, Woburn MA 01888-00044 U.S.A.

a). Select >File > load S19 record

10 1). Create the file HOTSHOT2.S19 based on the Appendix and place it into a temporary directory.

b). Select >Program

1). The Prog08SZ.exe program will read the HOTSHOT2.S19 file and translate this information into the FLASH program and too the threshold parameters.

15 2). The program will indicate when programming is complete.

It is appreciated that the software components of the present invention may, if desired, be implemented in ROM (read-only memory) form. The software components may, generally, be implemented in hardware, if desired, using conventional techniques.

20 It is appreciated that the particular embodiment implemented by the Appendix is intended only to provide an extremely detailed disclosure of the present invention and is not intended to be limiting.

25 It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described hereinabove but rather includes both combinations and subcombinations of the various features described hereinabove as well as modifications thereto which would occur to a person reading the foregoing which modifications are not in the prior art.

# APPENDIX

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**END OF PART B**

## PART C – THE PROVISIONAL'S ADDED SUBJECT MATTER

### BACKGROUND OF THE INVENTION

The following publications are believed to represent the current state of the art:

U.S. Patents: 6,164,564; 6,199,587 ;5,012,977 ;4,090,668 ;5,118,040 ;5,509,606 ;  
;5,354,965 ;5,254,083 ;5,118,040 ;5,012,977 ;4,106,508 ;4,090,668 ;3,979,068 ;5,354,965  
5,947,348 ;5,927,608 ;5,509,606 ;5,383,247 and 5,988,529 .

Published PCT Applications: WO 02/092237, WO 00/27540, WO 98/58826 and also  
the PCT that parts thereof are presented in Part B..

### SUMMARY OF THE INVENTION

The present invention seeks to provide improved apparatus and method for cleaning or  
de-icing vehicle elements.

## BRIEF DESCRIPTION OF THE FIGURES AND APPENDIX

The present invention will be understood and appreciated from the following detailed description, taken in conjunction with the drawings and appendix in which:

Fig. 25 is a simplified illustration of a heated liquid discharge system constructed and operative in accordance with another preferred embodiment of the present invention mounted in a motor vehicle;

Fig. 26 is a simplified exploded view illustration of a portion of the heated liquid discharge system of Fig. 25;

Figs. 27A & 27B are simplified front view and back view pictorial illustrations corresponding to Fig. 26;

Fig. 28 is a simplified sectional illustration taken along lines XXII - XXII in Fig. 27A;

Fig. 29 is a simplified sectional illustration taken along lines XXIII - XXIII in Fig. 27A.

Fig. 30 is a simplified timing diagram illustrating the operation of the system of figures 25 to 29.

Fig. 31 is a simplified illustration of the circular cylinder outer sleeve.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference is now made to Fig. 25, which is a simplified illustration of a heated liquid discharge system constructed and operative in accordance with another preferred embodiment of the present invention mounted in a motor vehicle. As seen in Fig. 25, an otherwise conventional motor vehicle 4100 is seen to incorporate a heated liquid discharge system 4102 constructed and operative in accordance with a preferred embodiment of the present invention. The heated liquid discharge system preferably includes a main assembly 4104, which provides liquid heating as well as electrical and liquid flow control functionalities. Main assembly 4104 is electrically connected via electrical cables 4106 and 4107 to a vehicle battery 4108.

A liquid inflow conduit 4110 supplies liquid, such as water or windshield cleaning liquid, from a vehicle liquid reservoir 4112, having an associated vehicle pump 4114, to main assembly 4104 .

A liquid outflow conduit 4122 supplies liquid to one or more sprayers 4124, which may be located at one or more of the following vehicle locations: front vehicle windshield, back vehicle windshield, side vehicle windows in general and especially in locations providing viewing access to vehicle exterior mirrors, vehicle headlights, vehicle rear lights and vehicle exterior mirrors.

A vehicle operator actuation switch 4130, typically located on the vehicle dashboard, is electrically coupled to main assembly 4104 by a control conductor pair 4132. A pair of vehicle computer interface conductors 4134 and 4136 interconnect the main assembly 4104 to the existing vehicle computer 4138. An ignition interface conductor 4140 interconnects the main assembly 4104 to the existing vehicle ignition switch.

**CK and IMP !** The vehicle's operator actuating switch 4130, is preferably intended for activating the automatic sprinkling cycles.

Preferably, several methods and ways exist, for example an alternative switch that might serve for a different operation activating mode. In the proposed alternative, a short depressing of the switch would actuate the automatic sprinkling. On the other end, a long depression interval, would cut off completely and close down the activity of the main assembly 4104 heating system.

Preferably, a combination of the switch with the software and hardware of the system, are able to provide this special mode of operational function.

Reference is now made additionally to Figs. 26, 27A, 27B, 28 and 29 (found in part B), which illustrate details of the structure and mounting of main assembly 4104. The main assembly 4104 is preferably mounted onto the vehicle chassis by a suitable mounting bracket, such as mounting bracket 4142. Mounting bracket 4142 preferably comprises suitably apertured chassis mounting portions 4144 and 4146 and a slide and snap fit main assembly support portion 4148 having slidable engagement indents 4150 and a snap fit engagement protrusion 4152 having indents 4154. The snap fit engagement protrusion 4152 may be injection molded of plastic directly onto the remainder of mounting bracket 4142.

Main assembly 4104 comprises a liquid heating chamber communicating with liquid inflow conduit 4122 and liquid outflow conduit 4110, a principal housing portion 4160, which is configured for removable snap-fit engagement therewith by a cover housing portion 4162. As seen particularly in Fig. 27B, the back surface of principal housing portion 4160 is formed with suitably undercut retaining protrusions 4164 which slidably engage corresponding corners 4166 of support portion 4148 underlying indents 4150. As seen particularly in Fig. 27A, the top surface of principal housing portion 4160 is formed with a pair of engagement guides 4168 and inclined snap fit engagement protrusions 4170 which engage indents 4154 in snap fit engagement protrusion 4152. Principal housing portion 4160 defines a generally circular cylindrical liquid heating chamber accommodating volume 4180, in a major portion of which is disposed a liquid heating assembly 4182. Liquid heating assembly 4182 preferably comprises a circular cylindrical outer sleeve 4184 having a base 4186, which defines a sealing ring retaining socket 4188, arranged to retain an insulating liquid sealing ring 4190.

A plurality of folded over heating elements, preferably two in number, designated by reference numerals 4194 and 4196, are located within sleeve 4184. Preferably heating element 4194 partially overlies heating element 4196, as seen in Fig. 29. Each of the folded over heating elements 4194 and 4196 preferably include a resistance heating element 4198, located within a heating element conductive sleeve 4200 and electrically insulated therefrom by an insulator 4202, such as a ceramic material.

The resistance heating element 4198 is preferably coupled at one end thereof to an electrical connection terminal 4204 extending outwardly of base 4186 and is coupled at an opposite end thereof to conductive sleeve 4200. The conductive sleeves 4200 of each of the folded over heating elements 4194 and 4196 are electrically coupled to ground via base 4186 and an electrical connector 4206. It is appreciated that the electrical characteristics of the resistance heating elements 4198 of the various folded over heating elements 4194 and 4196 are typically different from each other.

Principal housing portion 4160 also defines a liquid inlet channel 4210 and a heated liquid outlet channel 4212, both communicating with liquid heating chamber accommodating volume 4180, as well as a heated liquid temperature sensor mounting aperture 4214, also communicating with liquid heating chamber accommodating volume 4180. Liquid supplied to liquid heating chamber accommodating volume 4180

via liquid inlet channel 4210 preferably enters a liquid heating chamber 4216, defined by the interior of sleeve 4184, via at least two liquid inlet apertures formed in sleeve 4184, preferably a first aperture 4218 located near the base 4186 and a second aperture 4220, preferably located at an opposite side of sleeve 4184 and near the middle of the height of the sleeve 4184.

Normally, during operation of pump 4114 (Fig. 25), the level of the liquid exceeds the height of the liquid heating chamber and fills the liquid heating chamber accommodating volume 4180. The liquid drain apertures 4228 is located on a side of sleeve 4184 just below the top thereof, which permits draining of liquid from volume 4180 only down to the level of liquid drain apertures 4228, when the vehicle pump 4114 (Fig. 25) is not in operation. The importance of liquid drain apertures 4228 and its placement in the liquid heating chamber accommodating volume 4180 will be described below.

Liquid from reservoir 4112 (Fig. 25) is supplied by vehicle pump 4114 via liquid inlet conduit 4110 via a liquid inlet pathway portion 4250 of a liquid connector assembly 4252, which also defines a liquid outlet pathway portion 4254. Liquid connector assembly 4252 preferably comprises an injection molded element which also defines a differential pressure bypass pathway portion 4256, which is controlled by a spring loaded one-way valve 4258 and which permits liquid flow from liquid inlet pathway portion 4250 to liquid outlet pathway portion 4254 when the pressure differential thereacross reaches a predetermined threshold, typically 0.3 to 0.5 bar, which indicates the existence of a blockage in the liquid path through valve 4260 and the liquid heating chamber accommodating volume 4180.

Liquid inlet pathway portion 4250 preferably comprises a leaky one way valve 4260, preferably having a channel 4262 formed in a valve seat 4264 thereof, as shown in detail in Fig. 28. Valve 4260 preferably permits supply of liquid under pressure to the liquid heating chamber accommodating volume 4180 but restricts backflow therethrough to a relatively slow rate. The liquid passes through liquid inlet channel 4210 and fills the liquid heating chamber accommodating volume 4180. The liquid flows into liquid heating chamber 4216 via first and second apertures 4218 and 4220 in sleeve 4184, and elongated openings 4229 and 4231 (figures 28 and 31A, 31B).

The liquid is heated in liquid heating chamber 4216 and the temperature of the liquid or the air overlying the liquid, depending on the liquid level, is sensed by a temperature sensor 4270 commercially available from EPCOS AG. Corporate Communications of Munich, Germany, identified by Catalog No. G560/50K/F2 and located in heated liquid temperature sensor mounting aperture 4214. Temperature sensor 4270 preferably is mounted onto a printed circuit board 4272 which is mounted within principal housing portion 4160 and located outside of liquid heating chamber accommodating volume 4180.

Mounted on printed circuit board 4272 is control circuitry for operation of the main assembly 4104 which is connected inter alia to temperature sensor 4270, and - via a connector 4274 and a wire harness 4276 including a connector 4278 - to control conductor pair 4132, vehicle computer interface conductors 4134 and 4136 and ignition interface conductor 4140 (Fig. 25). Electrical cables 4106 and 4107 connect the vehicle battery 4108 (Fig. 25) to connection terminals 4280 of a plurality of relays 4282, which supply electrical power to electrical connection terminals 4204 of heating elements 4194 and 4196 via electrical connectors 4284. Relays 4282 are commercially available from TYH Enterprise Limited of Tsuen Wan, N.T., Hong Kong. Electrical connector 4206 provides a direct ground connection between base 4186 and the vehicle ground via one of electrical cables 4106 and 4107. An overheating cut-off fuse 4290 is also mounted onto printed circuit board 4272 and is connected to the control circuitry for shutting off power to the heating elements 4194 and 4196 in the event of overheating of the liquid heating assembly 4182. Fuse 4290 is preferably formed with an undersurface of a resilient material and is preferably retained in tight thermal engagement with the underside of base 4186 by a cover element 4292.

It is a particular feature of the present invention that the provision of liquid drain apertures 4228 in sleeve 4184 together with leaky one-way valve 4260 provide both overheating and antifreezing protection for the main assembly 4104. This synergetic functionality may be understood by considering the operation of the system following completion of a spray cycle. At this time, due to deactivation of pump 4114, liquid is not being pumped into liquid heating chamber accommodating volume 4180 and the liquid tends to drain slowly from volume 4180 via channel 4262, leaky one-way valve 4260, liquid inlet pathway portion 4250, liquid inlet conduit 4110 and vehicle pump

4114 to reservoir 4112. Such drainage continues until the level of liquid in liquid heating chamber accommodating volume 4180 reaches the level of liquid drain apertures 4228, at which point air, rather than liquid is drawn into channel 4262, effectively terminating drainage and retaining liquid inside liquid heating chamber accommodating volume 4180 at the level of liquid drain apertures 4228.

Retention of liquid inside liquid heating chamber accommodating volume 4180 at a level preferably not lower than that of liquid drain apertures 4228 ensures that the level of liquid in liquid heating chamber 4216 at least covers most of the heating elements 4194 and 4196, ensuring rapid heating of the liquid at the next heating cycle and avoiding burning out of the heating elements due to lack of liquid in the vicinity thereof. At the same time retention of liquid inside liquid heating chamber accommodating volume 4180 at a level- preferably not higher than that of liquid drain apertures 4228 ensures that sufficient freezing expansion volume is provided within volume 4180 and within the liquid heating chamber 4216 so that when the vehicle is not being operated and is in a freezing environment, freezing of the liquid therein does not cause cracking of the liquid heating chamber 4216 or of the liquid heating chamber accommodating volume 4180.

Reference is now made to Fig. 30, which is a simplified timing diagram illustrating the operation of the system of Figs. 25 to 29. As seen in Fig. 30, system actuation is preferably initiated by a user, such as the driver of a motor vehicle, pressing an operation actuation switch 4130, typically located on the vehicle dashboard. It is noted, however, that preferably, at all times that the vehicle is running at nominal idling or higher rpm, the system preferably maintains a standby heating state, except if the driver shuts off the system, for example by depressing - by a long interval, switch 4130.

Preferably, the system is maintaining a state in which - from the instant the key is inserted in the ignition switch and turning on the engine, until the instant that the vehicle's engine reaches its idling rpm, the system's heating current would not be activated.

For example, let us explain the operation of a system that preferably started operating at an ambient temperature of  $-18^{\circ}\text{C}$ .

The instant of transition 4500 **דורש שיפור** IMP **QRX** is the instant at which the engine passes /goes over the nominal idling rpm's. This is seen as THE IDLING LINE ? .

THE POINT 4500 ? in the timing diagram (figure 30).

The stages preceding the switch over WHY TRANSITION WHY NOT ACTIVATING ?? are not depicted in then diagram.

Identification of the engine's angular velocity (namely its rpm) and the indication when it reaches the "higher than idling" value can be – preferably – obtained by various methods.

One such method, preferably, relies on (continuous) measurement and sampling of the accumulator's voltage, as follows.

Prior to switching the engine ON, the voltage is, for example, approximately 12 volts.

When the starter is activated, the voltage drops by, say, approximately 5 V.

Once the engine revolutions exceed the idling rpm value, the voltage increases to over 12 volts, a value that preferably can be fed into the computer's software? Algorithm? Preferably, said instant at which the rpm reaches and surpasses the idling rpm, is identified and serves to provide a signal for turning the heating current ON.

Such an analysis can be preferably executed either within the heating unit, or alternatively by some other //computing/electronic/ unit of the car.

In the latter case (i. e., ~~performed somewhere in the car~~ // performed by a device in the car //), a signal is sent to the heating system in order to advise it that the required rpm's (higher than that of the idling state) was reached.

(p. 107) An alternate / different type for executing the measurement, is to preferably rely on measuring the engine's rpm / angular velocity by "counting"? the rate of pulses preferably received when the engine is turning, and providing a signal converting this information to express the "rpm above idling" state of the engine, which in turn is sent to ~~our~~ the heating system.

After the engine reached and passed the idling state rpm's, the system enters its first stage of the operation cycle which is ~~the~~ stand by mode. Heating element 4194 is actuated. Preferably, at this period a 17 amps current passes through the element (marked 4504 in the current graph). The temperature that is measured by sensor 4270

starts to rise at that instant (4506) and preferably stabilizes around  $56^{\circ}\text{C}$  (designated 4508 in the diagram).

In what follows, ON/OFF current control is preferably realized for current values ranging from zero to 17 amp.

Continuing the study of the process as expressed by the curves, we note the preferably value of 17 amp currents in the sections designated 4510.

Reverting to the sections marked 4508, the variation of the temperature as preferably measured by sensor 4270 is in the neighborhood of  $56^{\circ}\text{C}$ .

When a driver activates operation actuation switch 4130, preferably by depressing \_\_\_\_\_ switch button // button 45678, the system enters the automatic activation mode, at instant 4514 (see diagram).

In this mode, provided the driver does not shut down the operation of the system, two sprinkling cycles would preferably be executed.

During the same time span, the two heating elements 4194 and 4196 are activated, and a current of preferably 37 amps **ROGO not 17?** amps flows and the temperature of the heating elements ~~rises~~ increases. The duration of the heating period is shown in the diagram, designated 4516. ← **CHECK**

Preferably, at instant 4520 (see diagram), when the temperature that the temperature sensor 4270 is measuring reaches  $75^{\circ}\text{C}$ , the logic algorithm אמרתי מימיומן of the system employs this temperature value for triggering the first sprinkling (4522, see diagram, Fig 30).

It was programmed in the system operation algorithm, that the termination of the first sprinkling cycle would be preferably at the  $56^{\circ}\text{C}$  temperature value.

The duration (i. e., length) of the first sprinkling cycle – designated 4524 in the diagram, would preferably be approximately four (4) seconds, which approximately is the time required until the water cools down to  $56^{\circ}\text{C}$  as measured by sensor 4270 – providing the instant of termination of the first sprinkling - see temperature value  $56^{\circ}\text{C}$  at point 4528 in the diagram, marking the instant the first sprinkling stops.

Preferably at the termination time of the first sprinkling 4526, the temperature – as also measured by the sensor, starts to rise once again.

The algorithm of the system's logic, is programmed so that preferably when the temperature reaches again the value of 75°C, the system activates the second sprinkling cycle, as it did for the first sprinkling cycle. Obviously, other values can preferably be preferred, selected and set – eventually dictating to the internal computer the preferably sequences of the sprinkling cycles.

At instant 4514 – wherein the sensor measures once more a 756°C temperature, preferably the second sprinkling cycle is activated. The duration 4522 of this second sprinkling cycle, as determined by the system program, is preferably constrained by one of the following two conditions:

- The first condition is that the sensor would preferably measure a low temperature, of say 5°C;
- The second condition is that preferably, the duration of the sprinkling cycle, should not be longer than 8 seconds.

In the example that we exhibited, the temperature of 5°C at the time instant designated 4524, is the one that caused the termination of the sprinkling at the instant marked 4526. Following the time instant 4524, and while the engine is still running at an angular velocity higher than the rpm value of the idling state 4528, the current cutoff switch of heating element 4196 is shown at the time instant 4524. Preferable, somewhat later on, the flow of the 17 amp current continues to feed heating element 4194 and the system is preferably found to be in the standby mode instant of its performance.

Preferably, in the same manner and procedure as explained above, the temperature at the sensor is stabilized around the 56°C temperature, wherein the control regime of the temperature through the variations of the current is an alternating ON and OFF sequence.

←Rooooogo CFM(confirm) not clear in text: ON/OFF

Preferably, if the driver would not cut off the system through an initiated act by him, then preferably the system would be shut down at instant 4530, namely when the engine is shut off, and wherein preferably – considering the algorithm and the control program of the system, it would preferably happen when the engine's rpm drops below the idling rpm value as pre-set in the system.

The car. ?

Thus far we explained the operating logic with its algorithm and the operation of the system, where in preferably the driver activated the sprinkling after rather a long interval from the instant that the car's engine was started up.

Let us present now

Let us present now the circumstances arising from another mode (possibility) of executing the sprinkling by the driver's actions.

The driver enters the car, starts the engine and immediately activates the operator's actuation switch 4130. The system's operations and cycles sequences would be, basically, rather similar to those described above (the first example / selection).

The major essential difference is that the system would ~~preferably~~ skip the standby stage and directly (ישירות = מה?) heat the liquid with its two heating elements, 4194 and 4196. The temperature would reach 75°C (and this would be read by sensor 4270), and from this instant (point) onwards, the process would be identical to the one presented above.

Let us present now a sprinkling system whose characteristics /provide for// enable / exploiting the system in a better manner – through preferably an optimal performance from the point of view of attaining the desired heating, as well as better efficiency and utilization of the supplied heat energy, combined with better economical use of the volatile (evaporable) material that is found in the antifreeze liquid (e. g. alcohol or the like) and in particular in the manner and efficiency it removes the formed ice – as said – in the most optimal fashion (success?).

In the actual experiments carried out WITH WHICH / WHAT SYSTEM ? it was established that the range of relative higher temperature, say 75°C and 56°C for the first cycle, and a range of high (75°C) and preferably a low, 5°C, temperature at the termination of sprinkling instant, deliver the best optimal performance when the environmental temperature is around -18°C.

Studying the first cycle, it was found that the transfer of the de-icing / melting energy to the car windshield is done in a reasonable manner.

שלא אומר דבר

In the second sprinkling cycle there exists a stage at which the temperature of the liquid in the reservoir and that of the liquid being sprinkled are relatively low **EXAMPLE ? WHAT MEANS RELATIVE HERE ??** even at values under 40°C and as much low as to of 5°C.

At the temperatures just quoted above, the vaporization of the alcohol included in the antifreeze liquid is low. This causes at least two important phenomena:

First – lack of vaporization results in less squandered heating energy, and chiefly contributes to shortening the heating up time.

The second phenomena results in leaving a larger quantity of alcohol in the antifreeze liquid solution. This helps and enhances the melting of the ice process (as will be explained herein after).

In addition, the temperature of the flow of the liquid jet (or the sprinkled liquid “fan”) occur at relatively lower temperatures. The sprinkled liquid jet is alcohol rich (because, as said – it evaporation rate decreased – leaving more material in the antifreeze solution. When these liquid jet (or the sprinkled liquid “fan”) are impinging on the windshield (or any other surface being sprinkled), the ice or snow on the surface will not freeze anew, because as explained above – it is alcohol rich.

This essentially absence of freezing, combined with the mechanical action of the windshield wipers, was actually proven to provide optimal removal of ice and snow from the glass surfaces.

As expressed above, in the sequential second sprinkling cycle, that is preferably activated (started) when the liquids’ temperature is 75°C and is preferably terminated at the 5°C temperature level, the supply of active (hot) liquid is doubled. This larger liquid quantity delivers very good de-icing / snow melting action.

As a reminder, one should note that the liquid – now at 5°C temperature, is still at higher temperature than the typical environmental temperature, at say 18°C, and thus also under this extreme weather conditions it still acts as a melting inducing agent.

To recapitulate and emphasize: it was established (~~found~~) that the presence of alcohol rich liquid combined with the mechanical operation of the windshield wipers, provide optimal conditions for removing ice and snow from the glass surfaces, and this

combination is achieved by working at relatively lower antifreeze liquid temperatures, in accordance with the specific values presented in the discussion.

Consider now the computerizing aspect of the system, constructed to provide the operational logic and additional required functions.

Building the system      "בצורה כזו" איזה? Was intended to enable various future changes and modifications that might result from continued research and tested applications.

Moreover, this approach allows for incorporating specific changes and adaptations, as might required by potential future vehicle manufacturers and users and their specific needs or ideas.

As a specific example, a certain vehicles manufacturer demanded that instead of adjusting the system to be compatible with the rather common idling rpm of 800 revolutions, he should be able to have the system operating at another idling rpm value. Specifically, he required that the stand by rpm's shall be around 1,300 revolutions. The system built to suit his request, was actually built so it performs at this, 1,300 rpm value, without affecting other parameters nor harming the system performance. The request was accepted, and suitable systems were already delivered to jim.

~~Between~~ One of the reasons for "going down" from a three heating elements scheme to a two heating elements combination, was the demand of one customer to lower the specification of required heating current, practically from the common accepted current value of preferably 50 amps in our "three heating elements" system, to preferably 37 amps value. In order to adapt the system to be compatible with his specification, which meant lowering the total heating current needed to be supplied at times from 50 amps to preferably 37 amps, the two heating elements (with preferably 17 amps operating value system) was developed and delivered.

In order to enable a preferably swift reaction time, we introduced a

משפט לא גמור: "הכנסבו שילוב של ה-standby " ו-מה? ל-מה?

This (different?) arrangement for the standby stage, heats the liquid immediately after the car has been started, and thus provides an earlier (PRE?) heating time before the

sprinkling action is actuated, thus shortening the required time until the first sprinkling cycle can be activated.

Incorporating a combination of measuring the outdoors temperature and preferably inserting the data into the system, enables to change at will the temperature values (sprinkling start and end as related to sensor 4270 readings).

Said integration is preferably very important especially when the set temperature for termination of the sprinkling cycle is selected to be low, e. g. 5°C.

In order to clarify this point – note the explanation that follows.

If the environment (outdoors) temperature is -4°C, it becomes impractical to go down to sprinkling at 5°C חשבתי זה הפסקת החום? because the temperatures difference is small and hence the efficiency is low.

In such cases, preferably, we could resort to changing the set temperature upwards, for example to 15°C or another ?? which preferably can be selected after measuring the outdoors temperature and exploiting the knowledge to select a temperature that would provide better efficiency.

(you could say – preferably one can use different antireeze liquids)

But “P ← מחש חסר משמעות וחולי שונים מכילים יכולי מחש חסר משמעות

Different antifreeze liquids contain different volatile (vaporizable) liquids, such as alcohol, methanol and others. Reference to “antifreeze” and the volatile liquids they contain, is hence meant to be general – encompassing all common available types.

Reference is now made to figure 31, which is a simplified pictorial illustration of the circular cylindrical out sleeve 4184.

This unit is preferably made up of a metal pipe with various openings.

The openings were already described in the preceding text.

Elongated openings 4229 and 4231 were found to be suitable for the mixing requirements of the liquid entering then heating element, and thus for having the liquid in it attain a uniform temperature.

The described type of openings, are also amenable for providing convenient and easy assembly process.

The computerized (electronic) system and their hardware, which were described in figures 24A to 24H ROGO – THESE ARE NUMBEFRS BELOW

24G don't you hacve to change them ?

Considering the capabilities of the system – it is preferably po0ssible to maintain the algorithm and programs TOGETHJER WITH THE NEW ACTIVITY

רוגו – אני, אתה או שנינו הלכנו לאיבוד?

יש כאן עירוב חלקי הprovisional לדעתך, לא?

Yjay were explained in part C and that refers to the figures numbered 25 to 31.

PREFERABLY lines 3 & 4 your p. 117 – me not understand agree or explain please.

(77)

## PART C 1

Let us refer to the essential subjects of the flow path of the heated sprinkling liquid, and to the synergetic gains obtained due to the reduction of the part of the volatile liquids found in the antifreeze that vaporizes and is lost, when considering the liquid flow path from the heating reservoir and devices up to the sprinkling action at the sprayer and impinging on the surfaces to be de-iced or cleaned from snow.

We will refer to an example of a sprinkling action in which preferably the quantity of the volatile liquid (alcohol or the like) is preferably found in its maximal practical quantity.

In this path — the major components of the heating system are preferably the heating reservoir of the system, the piping and fixtures of the path to the sprayer and preferably at the end of the path, a sprayer or several sprayers. In here after, whenever referring to “piping”, we mean the tubes together with all their attendant accessories.

The subject of the preferably heating reservoir, was referred to in part C of this provisional.

As for the piping, there are many viable options. One simple option is the conventional piping already existing in the vehicles. Another option, is preferably the piping discussed in a former PCT of Microheat Inc., wherein (there) the tube through which the liquid flows to the sprayers is preferably located within a sleeve that contains, in addition, two more tubes. These additional two tubes serve for spinning the liquid on its way from the reservoir and back to it. In the PCT just referred to, the heating system is equipped with an auxiliary device for providing the spinning property.

It is preferably also possible, as explained in the above mentioned PCT, to perform the liquid's spinning through the sprayer/s.

Preferably, as presented in that PCT, and I will emphasize this fact once more, said method of spinning the liquid enables better performance of the task of maintaining the elevated temperature of the sprinkled heated liquid thus preventing harmful quick cooling of the sprinkled liquid.

It is evident from this discussion, that by adopting this approach, we can preferably use relatively lower heated liquid temperatures and yet supply a hot liquid at the output

nozzles —in a temperature that is approximately that of the liquid in the heating reservoir.

This capability preferably does not impel us to provide intensified heating of the liquid in the heating reservoir in order to overcome the cooling down of the liquid caused by conventional piping found in ambient environment temperatures of  $-18^{\circ}\text{C}$ .

The same claims may preferably also be relevant when referring to a sprayer through which we spin heated up liquid. Such a sprinkler, would preferably be warmer than its ambient temperature, especially if the ambient temperature is the frequently prevailing temperature in cold regions, e. g.,  $-18^{\circ}\text{C}$  (ca.  $0^{\circ}\text{F}$ ) that we quote as rather typical for those areas.

Hence we conclude that a sprinkling system, preferably with “a piping in a sleeve” and the spinning of the heated liquid property there and within the sprayer, result in an optimal system for sprinkling the liquid on the window surface while the liquid maintains a richer volatile (alcohol or equivalents) contents percentage as compared to the conventional sprinkler systems in vehicles.

Practically, any sprinkler existing in any car in the world whose configuration we will change in a manner that preferably the spinning liquid would flow through it — is bound to provide the optimal performance prevailing in our system — due to the fact that the liquid emanating from it will have a richer volatile contents than the liquid sprinkled from same sprayer without being endowed by the spinning variation.

The combination — spinning, heating, increased liquid volatile contents — thus enhanced wiping properties, might be deemed to possess the “innovative” properties amenable to patentable requirements.

In the above presentation, we did not yet refer to other variations and preferably adaptations that may be performed on sprayers, to instill optimal performance qualities in them.

Considering the attributes and behavior relating to vaporization of the volatile material in a liquid, and applying what we know from basic physic knowledge, we note that said vaporization of the volatile material from a liquid jet, or from a fan-like liquid sprinkling, and/or from liquid droplets in motion, depends on a host of factors.

Let's present some of these factors.

- A-1 • The velocity of the jet stream.
- A-2 • The surface area of the liquid relative to the volume of the liquid it envelopes.
- A-3 • The shape of the jet cross section, whether it is circular, cylindrical, or any other.
- A-4 • Relating to particles / droplets of the liquid, the configuration of the outer surface area of this entities that encompasses the volume of the droplet.

It is evidently clear that a sprayer that is partly clogged due to frozen entities at its nozzle outwards opening, would jet outwards a liquid whose configuration is far removed from optimal.

The spinning of warm/hot liquid within a sprayer would preferably enable its flow outwards in an optimal configuration, when one considers that preferably the heating up action would prevent the freezing of the liquid at the sprayer's nozzle, in a manner that the designed established as an/the optimal appropriate configuration.

Sprayers that are designed for sprinkling a liquid from them, in a manner compatible with attaining minimum loss of the volatile liquid as discussed above, would be basically based on optimization of the spraying characteristics, which preferably relates, inter alia, to all or part of the previous clauses – A-1, A-2, A-3 and A-4.

Slight variations applied to the sprayers would render them "optimal" from the attendant aspect of lower loss of volatile liquids as compared their earlier configuration and performance.

Changes such as preferably implementing internal spinning.

Some of the preferably recommended changes are given below.

- B-1 • Changing the spinning mode of the liquid within the sprayer.
- B-2 • Changing the flow path within the sprayer.
- C-3 • Changing the shape of the outwards opening of the sprayer.
- C-4 • Changing the number of openings of the sprayer.
- C-5 • Changing the dimensions of the openings of the sprayer.

Some of the above presented possibilities were actually implemented in a simple manner and did prove enhanced efficiency in relation to lowering the percentage of lost volatile material from the liquids being sprinkled by the sprayers.

From the above treatment, it becomes possible to stress once again the subject of "innovation" and the inventions inherent in the preferably above presented changes and additions, chiefly aimed at attaining optimal performance, inter alia by actually achieving reduced rates of loss of the volatile liquids arriving at the sprayer's openings.

YOFFEE

## CLAIMS

1. A heated liquid discharge system comprising:  
a main assembly which provides liquid heating and includes electrical and liquid flow control functionalities ;  
pump and a liquid inflow conduit supplying liquid from a liquid reservoir to said main assembly; and  
a liquid outflow conduit supplying liquid to at least one sprayer located at at least one location on a motor vehicle ,  
said main assembly comprising a liquid heating chamber communicating with said liquid inflow conduit and said liquid outflow conduit; and  
flow control is established through a temperature sensor that, in accordance with read temperatures, activates or shuts down the operation of said pump, and by this maintains the required temperature control.
2. A heated liquid discharge system comprising:  
a main assembly which provides liquid heating and includes electrical and liquid flow control functionalities ;  
pump and a liquid inflow conduit supplying liquid from a liquid reservoir to said main assembly; and  
a liquid outflow conduit supplying liquid to at least one sprayer located at at least one location on a motor vehicle ,  
said main assembly comprising a liquid heating chamber communicating with said liquid inflow conduit and said liquid outflow conduit; and  
in this activity, one sprinkling cycle is terminated at a low temperature.
3. A system in accordance with claim 2, wherein the low temperature at which the sprinkling cycle is terminated is higher than the environmental outdoor temperature, provided said one is below 0°C.

4. A system in accordance with claim 2, wherein one sprinkling cycle is terminated at a low temperature, that is set in accordance with performing measurements of the environmental temperature.
5. A system in accordance with claim 4, wherein the environmental temperature is the outdoors temperature in the vicinity of the vehicle..
6. A heated liquid discharge system comprising:
  - a main assembly which provides liquid heating and includes electrical and liquid flow control functionalities ;
  - pump and a liquid inflow conduit supplying liquid from a liquid reservoir to said main assembly; and
  - a liquid outflow conduit supplying liquid to at least one sprayer located at at least one location on a motor vehicle .said main assembly comprising a liquid heating chamber communicating with said liquid inflow conduit and said liquid outflow conduit; and  
whenever the system – in periods that are not sprinkling cycles, maintains a standby stage characterized by heating the liquid operation in accordance with the angular velocity (rpm's) of the engine.
7. A system in accordance with claim 6, wherein the standby stage in which heating is in progress, occurs provided the angular velocity (rpm's) of the engine is above a designated pre-set value.
8. A system in accordance with claim 6, wherein the standby stage in which heating is in progress, occurs provided the angular velocity (rpm's) of the engine equals the nominal idling rpm value or is higher than said rpm value.
9. A system in accordance with claim 6, wherein during the standby stage the heating current is lower than the designated maximum value of the system's heating current.

10. A system in accordance with claim 2, wherein the evaporation of the volatile liquids from the antifreeze liquid filling the heating reservoir due to the heating cycle thereof, as well as the evaporation of said volatile liquid flowing along the sprinkling path – until said liquid is sprinkled on the surfaces – is low.
11. A system in accordance with claim 2, wherein the evaporation of the volatile liquids during one sprinkling cycle is lower than the evaporation of the volatile liquids in a cycle preceding this cycle being referred to.
12. A system in accordance with claim 11, wherein the evaporation of the volatile liquids during sprinkling cycles is governed by a temperature sensor.
13. A system in accordance with claim 2, wherein one sprinkling cycle is terminated at a low temperature; and wherein the liquid flow is coupled with the operation of the windshield wipers.
14. A system in accordance with claim 13, wherein said large amount of the volatile contents in the liquid being sprinkled is coupled with said movements of the windshield wipers.
15. A system in accordance with claim 14, wherein the combination of said large amount of said volatile contents in the liquid being sprinkled and said movements of said windshield wipers prevent the freezing of said liquid being sprinkled on the surfaces being sprinkled upon.
16. A system in accordance with claim 15, wherein coupling of a sprinkling activity and said movements of said windshield wipers assist in achieving the goal of convenient and easy removal of snow, sleet and snow.

17. A method for controlling and operating heated liquid discharge system comprising a main assembly that provides liquid heating and its flow control through dedicated electronics circuitry and utilising a pump and a liquid flow conduit to supply said heated liquid from a reservoir to said main assembly and a liquid outflow supplying liquid to at least one sprayer on a motor vehicle .

Said main assembly comprising a liquid heating chamber communicating with said liquid inflow and outflow conduits, equipped with flow control based on a temperature sensor's readings that activates or shuts down the pump operation.

18. A method as presented in claim 17, with all components and features described therein, and that in addition performs the functions of heating the sprinkling liquid in a reservoir and performs activates controlled first and second sprinkling cycle tasks with a heated liquid from a chamber communicating with said liquid inflow and outflow conduit; and such that in this activity, one sprinkling cycle is terminated at a low temperature.

19. A method for controlling a heated liquid discharge system comprising a main assembly as provided in claims 17 and 18, with all the operational hardware associated computer operation and control systems as described in claims 17 and 18, supplying liquid to at least one sprayer located on a motor vehicle. Said main assembly comprising a liquid heating chamber communicating with in- and out-flow conduits and wherein in addition said liquid outflow conduit; and whenever the system – in periods that are not sprinkling cycles, maintains a stand-by stage characterized by heating the liquid operation in accordance with the angular velocity (rpm's) of the engine.

20. A heated liquid discharge system comprising:  
a main assembly which provides liquid heating and includes electrical and liquid flow control functions :  
pump and a liquid inflow conduit supplying liquid from a liquid reservoir to said main assembly; and

a liquid outflow conduit supplying liquid to at least one sprayer located at at least one location on a motor vehicle ,

said main assembly comprising a liquid heating chamber communicating with said liquid inflow conduit and said liquid outflow conduit; and

wherein, when the flow path of the heated liquid flowing from the heating reservoir, the continual piping and the sprayer, are optimal as per the aspect of reduced loss of the volatile liquids found in the liquid being sprinkled from the sprayer,

21. A system in accordance with claim 20, wherein parts of the tube conducting the sprinkling liquid, is adjacent to the spinning liquid from and to the heating reservoir.
22. A system in accordance with claim 20, wherein a liquid arriving to the sprayer from the heating reservoir and returning to it, is undergoing a spinning action in the sprayer.
23. A system in accordance with claims 20 and 21, wherein said tube and said sprayer referred to there in, are mutually combined.
24. A system in accordance with claim 20, wherein in its sprayer the inner liquid path of the liquid flow was changed relative to the path in the currently existing sprayers.
25. A system in accordance with claim 20, wherein its sprayer underwent a change of the shape of the liquid's exit nozzles as compared to the currently existing ones.
26. A method for discharging heated liquid, wherein the method is based on a discharge system comprising a main assembly which provides liquid heating and includes electrical and liquid flow control functions, combined with pump and a liquid inflow and outflow conduits supplying and returning said liquid to said

heating reservoir, said liquid being supplied to at least one sprayer on a motor vehicle, and wherein, when the flow path of the heated liquid flowing from the heating reservoir, the continual piping and the sprayer, are optimal as per the aspect of reduced loss of the volatile liquids found in the liquid being sprinkled from the sprayer,

## ABSTRACT

A provisional for enabling variations of an earlier PCT in order to extend its applicability to a wider public differing in their requirements is presented. It is made up of three parts: (a) "Structure of this provisional", (b) The basic PCT, (c) The added body" – presenting the adaptations and improvements.

### The PCT -

A liquid heating assembly including a heat-conductive displaceable element and a liquid heating enclosure forming a liquid heating volume including a primary liquid heating volume and a secondary liquid heating volume. The primary liquid heating volume includes a heat exchanger for directly heating the liquid in the primary volume plus indirectly the secondary liquid heating volume.

### The Added Provisional Treatise

A heated liquid discharge system comprises a main assembly heats the liquid for cleaning or deicing snow and ice covered vehicles' windshield surfaces. It includes electrical and liquid flow control combined with a pump and liquid flow conduits supplying liquid from a reservoir. Main assembly and a liquid outflow conduit supply liquid to one or more sprayers located on a motor vehicle, sprayer also located on the motor vehicle.

Flow control is established through a temperature sensor that reads temperatures and activates / shuts down the pump operation.

A salient adaptation feature is reduction of the required heating current (by approximately 30%), enabling vehicles with lower amp-hours capacity to enjoy the benefits of this system.

## 51677 PART D – THE PROVISIONAL'S ADDED SUBJECT MATTER

### BACKGROUND OF THE INVENTION

The following publications are believed to represent the current state of the art:

U.S. Patents: 6,164,564; 6,199,587 ;5,354,965 ;5,012,977 ;4,090,668 ;5,118,040 ;5,509,606 ;  
;5,383,247 ;5,354,965 ;5,254,083 ;5,118,040 ;5,012,977 ;4,106,508 ;4,090,668 ;3,979,068  
5,947,348 ;5,927,608 ;5,509,606 and 5,988,529 .

Published PCT Applications: WO 02/092237, WO 00/27540, WO 98/58826 and also the PCT that  
parts thereof are presented in Part B.

### SUMMARY OF THE INVENTION

The present invention seeks to provide improved apparatus and method for cleaning or de-icing  
vehicle elements.

## BRIEF DESCRIPTION OF THE FIGURES

The present invention would be better understood and appreciated from the following detailed description, taken in conjunction with the drawings and the appendix, in which:

Fig. 32 is a simplified sectional illustration of the main assembly (a unit based on the concept of the unit presented in Fig. 22), constructed and operative in accordance with another preferred embodiment of the present invention, mounted in a motor vehicle;

Fig. 33 is a simplified sectional illustration of the main assembly constructed and operative in accordance with another preferred embodiment of the present invention, mounted in a motor vehicle;

note that this unit is equipped with one liquid discharge exit but with two inputs for the liquid. Note also that one of them is closed by a cover.

Fig. 34 is a simplified sectional illustration of the main assembly constructed and operative in accordance with yet another preferred embodiment of the present invention, mounted in a motor vehicle;

This unit's construction is based on the design of the unit depicted in Fig. No. 33.

Note that this unit is equipped with two inputs for the liquid. Moreover, the two inputs of the liquid are connected to bi-directional valve.

Fig. 35 is a simplified sectional illustration taken of the main assembly constructed and operative in accordance with another preferred embodiment of the present invention mounted in a motor vehicle.

This unit's construction is based on the design of the unit depicted in Fig. No. 33.

Note that this unit is equipped with two inputs for the liquid, the two inputs of the liquid are connected to a bi-directional valve.

Fig. 36 is a simplified sectional illustration taken of the main assembly constructed and operative in accordance with another preferred embodiment of the present invention mounted in a motor vehicle.

Fig. 37 is a simplified exploded view illustration of a heating chamber. A heat sink is mounted on this heating unit.

Fig.38A is a simplified pictorial illustration of the heating chamber presented in Fig. 37.

Fig.38B shows a top view presentation of the heating chamber shown in Fig. 38A.

Fig.39A is a simplified sectional illustration of the liquid heating chamber along lines XXXIX - XXXIX in Fig. 39B, wherein, as seen, several flow directions of the liquid are discernable in the shown cross-section.

Fig.39B presents a top view of the liquid heating chamber that is depicted in Fig. 39A, wherein several flow directions of the liquid are discernable in the shown cross-section view of the unit.

Fig.40 is a simplified isometric sectional illustration of a liquid heating chamber, taken along lines XL - XL in Fig. 38B.

Fig.41A and Fig. 41B are simplified sectional illustrations of the liquid heating chamber, taken along lines XXXIX - XXXIX in Fig. 39B, wherein one can observe, respectively, a normal and operating fuse in one of them, and a melted fuse that cut-off the electric circuit (contact) in the second figure.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference is now made to Fig.32, which is a simplified illustration of a main assembly 5104 constructed and operative in accordance with another preferred embodiment of the present invention mounted in a motor vehicle.

Leaky one way valve 5260 (shown in Fig. 32) is based on the leaky one way valve 3260's structure (Fig. 22), wherein we introduced a difference in its construction, as evident in Fig. 5260 as compared to the 3260 leaky valve. The essence of the change is that leaky one way valve 5260 was manufactured without the ball that exists in leaky one way valve 3260 of figure 22.

Let's refer to Fig. 22, and study some of the functions that applied to the leaky one way valve 3260.

Quoting from the description that refers to Fig. 22. Quote:

"Liquid inlet pathway portion 3250 preferably comprises a leaky one way valve 3260, preferably having a channel 3262 formed in a valve seat 3264 thereof, as shown in detail in Fig. 22. Valve 3260 preferably permits supply of liquid under pressure to the liquid heating chamber accommodating volume 3180 but restricts backflow therethrough to a relatively slow rate".

Unquote.

The main reason for removing the ball from the leaky one way valve 3260, was the will to eliminate the phenomena of water and/or vapor flow from the sprinklers upon the hood or the windshield's glass while the liquid is being warmed up in heating unit 3104.

By removing the ball from the leaky one way valve 3260, a function that was operative in the former leaky one way valve, was cancelled.

Consider this situation: the removal of the ball from the leaky one way valve 3260 cancelled the function that "restricted backflow therethrough to a relatively slow rate". The removal of the ball enabled the driving of a speedy flow as a backflow from the sprayers 3124 back to the reservoir (3112). Verily, the main reason for removing the ball from the leaky one way valve 3260 was indeed to cancel this phenomena of a back leak flow of liquid or vapors from the sprayers, preferably protecting the hood and the windshield's glass during the duration of heating the liquid in unit 3104.

This variation, of preferably manufacturing the unit without the ball, is the major variance between main assembly unit 3104 and main assembly 5104.

This variance in production, might be used for manufacturing the units both as units for OEM marketing and as "After Market" parts.

A certain disadvantage exists when manufacturing the units without the ball in them, namely, that there is no immediate, convenient way to re-introduce the ball into the device – if it one wants it there, without dismantling and re-assembling the unit – if the functional properties of the system are to be modified.

Reference is now made to Fig.33, which is a simplified illustration of a main assembly 5504 constructed and operative in accordance with another preferred embodiment of the present invention mounted in a motor vehicle.

Main assembly 5504 is essentially similar to main assembly 3104 (Fig. 22). The major difference between the two units is expressed by the following additions and changes:

Ball 5752 was introduced into the leaky one way valve 5660 unit.

Liquid inlet pathway portion 5758 was added.

Liquid inlet pathway portion 5758 was connected with leaky one way valve 5660 at the entrance of 5760.

A cover 5764 was introduced, to cover liquid inlet pathway portion 5758.

Through the additions and changes that we introduced we formed a condition that brings main assembly 5504 (described in Fig. 33) to be identical with main assembly 3104 (described in Fig. 22) – as far as the following operational functions are considered: operation, hydraulic, heating and the flow of the liquid to sprayers 3124, and from sprayers 3124 back to reservoir 3112.

The liquid enters into main assembly 5504 in the main flow direction 5762, via liquid inlet pathway portion 5650 while passing through the leaky one way valve 5660. A backwards flow in an opposing direction would flow at the so defined "leaky level" back to reservoir 3112 from the sprayers 3124.

The description of the main assembly 3104 (in Fig. 22) might be viewed as appropriate for explaining main assembly 5504 in Fig. 33, and hence it would be superfluous to repeat it herein under.

It is possible, employing the additional "liquid inlet pathway portion" (5758) and the cap 5764, to use the same main assembly unit 5504 in a variety of different operational modes, without having to recourse to dismantling the internal parts of the main assembly 5504.

Two out of the various operational forms will be explained later on, when describing figures 34 and 35.

Reference is now made to Fig.34, which is a simplified illustration of main assembly 5804 constructed and operative in accordance with another preferred embodiment of the present invention mounted in a motor vehicle.

Main assembly 5804 (Fig. 33) is based upon the structure of main assembly 5504 (Fig. 33) wherein the major variance between the units is expressed by the following additions and changes. The addition of a bi-directional faucet 5810, such that from its entrance opening 5812 it is possible to lead the flow path of the liquid to an upper exit opening 5816 of the faucet or to a lower drain exit opening 5820 of the faucet.

Upper exit opening 5816 is connected to liquid inlet pathway portion 5650 through tubelet 5824.

Lower exit opening 5820 is connected to liquid inlet pathway portion 5758 through tubelet 5826.

A bi-directional faucet 5810 is provided in a state wherein it is open to bi-directional flow of the liquid from its inlet opening 5612 to an bottom exit outlet opening 5820 (and from the bottom exit opening to the opening.5660).

At the state at which a bi-directional faucet 5810 it is found, it creates a condition such that the system by-passes the leaky one way valve 5660 that contains ball 5752.

Switching over the bi-directional valve 5810 into the by-passing position of the leaky one way valve 5660 (the lever of the valve 5811 positioned in the state defined in Fig. 34 bring the main assembly 5804 system (Fig. 34) to an activity state identical to state defined in Fig. 32 for the Main Assembly 5104.

The state defined in Fig. 34 enables free flow of the liquid in the direction shown by the arrows 5830, 5832, 5834 and arrows 5836.

Subject to the additions and changes that were introduced, we created a state of affairs that brings main assembly 5804 (described in Fig. 34) and main assembly 5104 (described in Fig. 32) to be:

identical, from the point of view of its operational functions, hydraulics, heating and the flow of the liquid to sprayers 3124, and from sprayers 3124 back to reservoir 3112. The explanation was given before (in the description of Fig. 32).

Reference is now made to Fig.35, which is a simplified illustration of a main assembly 5904 constructed and operative in accordance with another preferred embodiment of the present invention mounted in a motor vehicle.

Main assembly 5904 is based on the structure of main assembly 5804 (Fig. 34), wherein the only difference between these two main assemblies is the variance in the state of the faucet's lever 5811 from the state shown in Fig. 34, to the position of faucet's lever 5911 shown in Fig. 35.

In the state at which the bi-directional faucet 5910 with faucet's lever 5911 is shown in Fig. 35, it blocks the flow passage to the bottom exit opening 5820 and blocks the flow passage to the upper exit opening 5816, thus enabling the flow of the liquid through the leaky one way valve 5660.

This state of the faucet's lever 5911 in Fig. 35 leads the main assembly 5904 (Fig. 35) to an operational activity condition identical to the one shown in Fig. 33 for main assembly 5504.

Preferably, this state defined in Fig. 35 enables bi-directional flow of the liquid in the directions of arrows 5940, 5942 and arrows 5944.

To recapitulate this result: it is noted that the flow of the liquid is free through the leaky one way valve 5660.

On the other hand, the flow of the liquid from sprayers 3124 main assembly 5904 and through the leaky one way valve 5660 is a restricted flow, flowing at the restricted flow that the leaky one way valve 5660 enforces.

By varying the state of faucet's lever 5911 (as in Fig. 35) we introduced a situation that leads main the main assembly 5904 described in Fig. 35 and main assembly 5504 described in Fig. 33, to be identical, from the point of view of its operational functions, hydraulics, heating and the flow of the liquid to sprayers 3124, and from sprayers 3124 back to reservoir 3112. The explanation was given before.

Similarly to the explanation relating to Fig. 22, and in accordance with the quotation cited below for Fig. 32, the same activity functions also exist in the main assembly 5904 of Fig. 35.

It is a particular feature of the present invention that the provision of liquid drain aperture 3228 in sleeve 3184 together with leaky one-way valve 3260 provides both overheating and anti-freezing protection for the main assembly 3104.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference is now made to Fig.36, which is a simplified illustration of main assembly 6004 constructed and operative in accordance with another preferred embodiment of the present invention mounted in a motor vehicle.

Preferably, the main assembly 6004 unit is basically based on main assembly 3104 shown in figures 20, 21A, 21B, 22 and 23, whereas the main differences are related to the liquid heating chamber 6316 and the parts associated with it.

A second, detailed discussion of the variance between the two, would be given below, as part of the description and explanations of the following figures.

Reference is now made to figures 37, 38A, 38B, 39A and 39B, which present a simplified illustration of main assembly 6104 constructed and operative in accordance with another preferred embodiment of the present invention, preferably mounted in a motor vehicle.

Fig. 37 constitutes an exploded view of the liquid heating chamber 6316 assembly.

Preferably, principal housing portion 6160 (Fig. 36) comprises a generally circular cylindrical liquid heating chamber accommodating volume 6180, in a major portion of which is disposed a liquid heating chamber 6316. Liquid heating chamber 6316 preferably comprises a circular cylindrical outer sleeve 6184 having a base 6186, which defines a sealing ring retaining socket 6188, arranged to retain an insulating liquid sealing ring 6190 (Fig. 36).

A plurality of heating elements, preferably two in number, designated by reference numerals 6192 and 6194 and 3196, are located within sleeve 6184.

Preferably, two halves (6193, 6195) of heat sink (6---) are being connected to the two heating elements 6192 and 6194. The contact might preferably be done by soldering or by any other connecting method that would provide a good heat transfer between the two items (namely, heating elements 6192 and 6194 and heat sinks 6193 and 6195, respectively). Preferably, in this bonding together process, the two parts of the heat sinks participate and preferably openings 6310, 6312 and 6314 serve for passage of the liquid through the heat sinks. Preferably, such opening are embedded in all the heat sinks.

Openings 6332, 6333 and 6334 are preferably openings in sleeve 6184. Such openings might be encountered in small quantities and also in larger quantities, preferably in all kinds of shapes and geometries and preferably in a variety of places on the units.

The openings are preferably designed mainly in order to enable liquid flow through sleeve 6184, a flow that essentially most of it is preferably into sleeve 6184.

Note that fuse housing 6330 is connected to the base. Further details about the fuse will be provided in figures 40, 41A and 41B.

Reference is now made to Fig. 38A and Fig. 38B.

Fig. 38A is a simplified exploded isometric view illustration of a heating chamber 6316.

Fig. 38B is a simplified pictorial illustration of the heating chamber presented in Fig. 38A. In this top view, the shape of the profiles from which preferably the heat sink is constructed, is clearly seen.

Reference is now made to figures 39A and 39B, which are simplified illustrations of a liquid heating chamber 6316.

Fig. 39A is a cross-section view of the XXXIX – XXXIX section of the liquid heating chamber 6316 that is marked in Fig. 39B. Preferably, the positioning selected for the heat sinks 6193 and 6195 is fixed by considering the properties of the heating elements 6192 and 6194 positions. The heating elements are preferably connected to the base 6186, preferably by soldering.

The locations of the heat sinks, 6193 and 6195, are preferably selected so that a flow gap would remain between the lower surface 6370 of the heat sink and the upper base surface 6372 of the heat sinks base 6186.

The lengths of each of the heat sinks 6193 and 6195 is such, that preferably a gap enabling internal flow between the heat sinks' upper surface 6376 and the upper surface 6378 of the cylindrical outer sleeve 6184 would be maintained.

Flow of the liquid inside liquid heating chamber 6316, preferably in various different directions, is provided. Preferably, liquid flow is being generated because of the differences of temperature that exist in the liquid. Thus, liquid flow is preferably generated and maintained when the liquid enters the liquid heating chamber 6316.

Preferably, those flows generate homogenization effects in the liquid – higher uniformity of the liquid's temperature in the liquid heating chamber is achieved.

The uniformity thus obtained, preferably raises the efficiency of the heating of the liquid and its spraying effects.

The major flows happen preferably in the directions depicted by the arrows 6340, 6341, 6342 and 6344.

Preferably, liquid is flowing through the openings 6310, 6312 and 6314.

These flow patterns – some of them designated by arrows 6346 and 6347, are characterized by the fact that preferably they pass through the openings located in the heat sinks.

These liquid flows can be preferably maintained along the directions of the arrows 6346 and 6347 and preferably also in the opposite directions to those of the arrows.

Flow in the direction of arrow 6340 happens preferably in the upper part of the liquid heating chamber 6316 – preferably from the inner space of the heat sinks to the inner space of the cylindrical outer sleeve 6184.

Flow in the direction of arrow 6344 (Fig. 39A ) runs preferably in the lower part of the liquid heating chamber 6316 – preferably from inner parts of the heat sinks to the inner space of the heat sinks 6193 and 6195.

The above mentioned variety of flow, preferably cause homogenous temperatures distribution in the liquid heating chamber 6316, and hence a measurement of the temperature of the liquid at the exit opening might preferably be considered adequate for indicating the liquid's average temperature within the heating chamber 6316. Managing the temperature and flow controls, done in accordance with measuring the temperature of the liquid at this point, enhances the efficiency of the heating and the spraying. This approach preferably enables to perform better spraying cycles of liquid from the sprayers when its temperature is within a pre-selected range of preferably desired temperatures.

This feature, used in the present invention is important in certain cases in order to conform to the requirements and specifications of the vehicles' manufacturers, who dictate an upper limit to the temperature allowed for spraying.

As cited above, heat sinks 6193 and 6195 are preferably connected to heating elements 6192 and 6194, respectively. This arrangement, increases the capability of the system's heat transfer from heating elements 6192 and 6194 to heat sinks 6193 and 6195, and from there - to the liquid..

In tests that were conducted, it was established that with two heating elements, into which two heat sinks are connected, preferably as shown in figures 39A and 39B, the efficiency of heat transfer to the liquid is better than that achieved with three (and longer) heating elements, that are seen in Fig. 22.

The new configuration of integrating the heat elements with the heat sinks formed an added reservoir within the existing liquid heating chamber 6316. Preferably, this added reservoir contributes, inter alia, a better heat transfer to the liquid, as well as to higher uniformity of the temperature in the cylindrical liquid heating chamber as claimed above.

The tests did prove that this system provides faster heating, increased spraying cycles rate capability, and it becomes possible to reduce the maximal electric current values of the heating elements.

An additional advantage of the liquid heating chamber 6316 presented in Fig. 39A vis a vis that of Fig. 22 (the one with three bent heating elements), is that it has a larger volume of liquid (stored and heated).

One more additional advantage of the liquid heating chamber 6316 presented in Fig. 39A as compared to the one presented in Fig. 22 (the one with three bent heating elements), is that the pressure drop (i. e., the hydraulic resistance to the liquid's flow) is lower in the liquid heating chamber 6316 of figure 39A.

The reduction of the pressure to the liquid flow is a severe requirement, dictated by car manufacturers. Among their specifications, a maximal pressure drop is specified, for example 0.3 Atmospheres by one manufacturer, that is permitted for the main assembly 6104.

As cited above, heating elements 6192 and 6194 are preferably connected to base 6186, and heat sinks 6193 and 6195 are connected to the heating elements.

The structure is such, that preferably a gap is formed between the heat sinks and the base, namely between heat sink's bottom surface (6370) and upper surface (6372) of the base 6186.

Preferably, the heating elements heat up the liquid – and part of this heat energy passes preferably directly to the base. The quantity of this transferred heat is relative to the temperatures difference

between the envelope of the heating element (which is in direct contact with the base) and the temperature of the base proper.

This fraction of the energy constitutes energy loss (verily – wasted) on the one side, and unnecessary heating of parts that are in direct contact with it on the other side.

Non desirable heating of the plastic material constituting the principal housing portion (6160) followed by heating of the sealing gasket in groove 6188 cause enhanced wear, harmful to these parts and might even ruin them altogether.

In our specific case, this means potential damage to the area of the sealing constituents of the liquid volumes, which might lead to leaks rendering these parts non-serviceable and even requiring their replacement.

It was pointed out earlier (refer to the description of Fig. 39A), it was explicitly cited that preferably there exists a gap between heat sinks 6193 and 6195 and the base (6186).

Two major factors that cause the heating elements' area to be at a lower temperature than the one that would be achieved without using the heat sinks have to be considered.

The first factor: the heat sinks causes high cooling of the heating elements.

The second factor: a large part of the heat (energy) that was produced by the heating elements is transferred to the heat sinks. This heat does hardly reach to the base 6186, as most of it is transferred to the liquid.

Hence – because of the selected structure, we ended at a system with a side effect that increases the thermal efficiency of the system together with decrease of probable damage at the contact area of the base with its adjacent parts.

The three added volumes that preferably were formed for the liquid, which we introduced when referring to liquid heating chamber 6316, increase the thermal efficiency of main assembly 6104 – when the system is heating up the liquid without driving it to flow. The heating effect is generated by the heating elements which are preferably at a higher temperature than those of other parts of the system.

Part of this heat is transferred to the liquid found within the volumes of the heat sinks. Through the heat sinks, part of the heat is transferred to the volume “residing” between the volumes between the heat sinks and the cylindrical liquid heating chamber 6184, and from there – preferably by the liquid itself – another part arrives at the cylindrical liquid heating chamber 6184.

Preferably, through the side walls of the cylindrical liquid heating chamber, part of the heat is transferred to the liquid volume found at the cylindrical liquid heating chamber and from there to principal housing portion 6160 (Fig. 36).

It is well known that transferring heat by a flowing liquid is the best way for transferring heat, whereas a partial blocking of the flow would drastically reduce the heat transfer. The profusion of volumes and/or their partitions walls reduce the liquid capability to flow between the chambers volume, and thus substantive reduction of the heat transfer capability from the heat sinks to the of main assembly 6104 results.

We stress the fact, that preferably the reduction of heat transfer top the main assembly, contributes to an increase of the thermal efficiency of the main assembly (6104).

At the time the liquid is flowing, heat transfers also occurs preferably between the liquid of the heating elements to the principal housing portion 6160. Heat that arrived at the outer volumes of the flow would preferably heat them up, too.

As the forced flow continues, this heated liquid enters the inner volumes, where it is subject to additional heat input.

Actually, the heat received by the liquid in the external volumes of the heat sinks would be returned to the system and would not be lost.

Hence, it is concluded that the profusion of chambers and many partition walls, indeed increases the efficiency system's performance.

Experiments carried out at the laboratories of Microheat enterprises, have actually proven this statements.

Reference is now made to figures 40, 41A and 41B, which present simplified illustrations of a liquid heating chamber 6316.

A fuse 6390 is presented in these figures. This fuse is preferably connected to base 6186, preferably by soldering.

The current to heating elements 6192 and 6194 passes through this fuse. For the sake of the following explanation, let's assume that the input of the current to the heaters starts at an electrical connector point 6399. From there the current passes, preferably through the first end of the heating elements 6192 and 6194, towards the other ends of the heating elements that are preferably

connected to the metal body of the heating elements, and from there to the base 6186. Up to this point in our presentation (of the current path) is a straight forward one as common in electrical heaters and does not call for elaboration.

Further "down the road" (along the current path) to the electric contact point 6398, the current passes through the fuse, as will be explained below.

From base 6186, the current passes to fuse housing 6392, which is preferably made of metal, to enable electric current to run through it. From fuse housing 6392, the current proceeds to soldering material 6396 at an outer zone of the soldered 6393, and from there preferably through the soldered material 6396, to an internal area of the soldered material 6395, and then preferably to an electricity contact 6398.

The electric path through the system and its auxiliaries was described above, for passing through a fuse under normal condition (the fuse is intact).

Insulator 6394, preferably made of plastic material, serves for locating an electricity contact 6398 within the fuse housing 6392, and this – inter alia, for potentially additional manufacturing tasks.

When a problem develops in the liquid heating chamber 6316, e. g., there is a very low - or not at all liquid in the liquid heating chamber 6316, we are exposed to the danger of over-heating related malfunctions.

If we activate the system at under these conditions, activation of the heating elements might result in internal heating of the liquid heating chamber 6316.

The temperature sensor at the exit outlet of the liquid would not detect this temperature rise accurately, and hence would not trigger the electric current shut down because of this non-detected anomalous temperature rise. The increased internal heating of liquid heating chamber 6316 and the increased heating of heating elements 6192 and 6194 would cause overheating of base 6186 which in turn would preferably cause increased heat in fuse housing 6392.

When the temperature at fuse housing 6392 exceeds the melting temperature of the soldered 6396, preferably the soldered material will melt and drip – as illustrated in Fig. 41B. The dripping of the melted solder material 6399 would preferably ensue the cut off of the electricity circuit continuity between fuse housing 6392 and the electricity connection 6398.

This circuit break down, is a one-time occurrence and provides protection against damage to the vehicle in which this safety device is installed. Note that because a failure of this nature is a critical failure, several vehicles' manufacturers decided that this fuse should preferably be a one-time fuse (rather than one that can be re-activated).

Because, as said, this kind of a malfunction is a critical one, several vehicles' manufacturers specified a protection that preferably is not only software dependent and required a fool-proof safe protection for shutting the electric current supply at on occurrence of this critical overheating problem malfunction.

Installations of this type, and tests that were performed for and with manufacturers, have proven the validity of this concept.

Let's consider several additional points regarding the protection against overheating that are provided by the system.

Essentially, overheating might occur in what we would like to refer to as "two levels". Let's call one "the low level of the elevated temperatures" and the other one "the critical level of the elevated temperatures".

The low level of the elevated temperatures is encountered when the liquid heating chamber 6316 is full or partially full.

The "critical level of the elevated temperatures" we referred to, is encountered and results in overheating when there is no (or nearly no) liquid in the liquid heating chamber 6316.

To stress a point – the temperatures of the heating elements 6192 and 6194 – when they are being heated up without transferring their heat to the liquid, might rise up to approximately 600°C. Such a high temperature might, if not dealt with quickly, cause damage to the vehicle in which the unit is installed.

The fuse 6390 was developed and installed to preferably handle "The critical level of the elevated temperatures" potential occurrence and its ensuing potential damages. It was found that this solution conforms to the requirements and specifications of the vehicles' manufacturers that tested it.

For "the low level of the elevated temperatures" potential occurrence, several preferably software based protection answers were installed. These protection means rely on temperature measurements, with or without linked measurement of times (duration, etc.) such as instants at which temperature detected by the sensors starts to In summary: there are some methods based preferably on temperature sensors and activation of protection means, such as preferable current

cut off, and other that integrate temperature measurements and times data to preferably react as necessary.

We find it appropriate to add some comments regarding the logic of protection actually used for treatment of the "low level range of the elevated temperatures" protection means.

The logic contains protections as follow:

1. Spray any way if high level of predetermined temperature ( $70^{\circ}\text{C}$ ) is not reached during certain time of the heating process.
2. Spray by time if low level of predetermined temperature ( $53^{\circ}\text{C}$ ) is not reached during spraying.
3. Stop working if certain temperature is not reached during first 20 seconds of the heating process (protection against empty liquid heating chamber).
4. Stop working if during spraying certain delta temperature is not reached (protection against empty reservoir or liquid heating chamber of system).
5. Stop working if sensor senses too high temperature (over heat protection  $85^{\circ}\text{C}$ ).
6. Stop working if voltage is lower than predetermined (overload protection 10 V).
7. Stop working if voltage is higher than predetermined (protection against problem in electrical system of car, 16.4 V).
8. Stop working if the temperature on the PCB is higher than predetermined ( $125^{\circ}\text{C}$ ).
9. Stop working if microprocessor will detect problem with temperature sensor.

## CLAIMS

1. A heated liquid discharge system comprising:  
a main assembly which provides liquid heating and includes electrical and liquid flow control functionalities;  
pump and a liquid inflow conduit supplying liquid from a liquid reservoir to said main assembly; and  
a liquid outflow conduit supplying fluid to at least one sprayer located at at least one location on a motor vehicle.  
Said main assembly comprising a liquid heating chamber communicating with said liquid inflow conduit and said liquid outflow conduit; and  
within said liquid heating chamber there exists at least one heating element in contact with a heat sink that transfers the heat energy to the liquid.
2. A system in accordance with claim 1, wherein at the heat sink there exists at least one flow passage for the liquid.
3. A system in accordance with claims 1 and 2, wherein at the heat sink there is a free passage for the flow of the liquid through it.
4. A system in accordance with any of claims 1 to 3, wherein said flow passage at said heat sink forms a reservoir-like open volume.
5. A system in accordance with claim 4, wherein the heating element is connected to the heat sink's base and dictates a flow passage between the base (6186) and the heat sink's bottom (6370) that enables flow passage of the liquid into the heating element (6193).
6. A system in accordance with claims 4 and 5, wherein the upper end (6373) of the heat sink allows for a flow gap between it and the adjacent side wall (6378).

7. A system in accordance with any of claims 4 to 6, wherein the gaps enable a spinning flow within the reservoir like volume that is contained in the heat sink.
8. A system in accordance with claims 1 and 2, wherein there exists at least one opening in the heat sink's side wall enabling liquid flow through it.
9. A system in accordance with claims 1 and 4, wherein the reservoir-like open volume exists as an inner volume within a reservoir around it (6195) and between them an intermediate volume exists.
10. A system in accordance with claims 7 and 9, wherein part of the spinning activity of the liquid takes place between the intermediate volume and the reservoir-like open volume located in the heating element.
11. A system in accordance with claim 10, wherein at least a part of the spinning activity of the liquid, takes place through at least one opening (6312) located at said heat sink's side wall.
12. A system in accordance with any of claims 1 to 11, wherein the spinning activity of the liquid causes to introduce homogeneity of the liquid found within the liquid heating chamber.
13. A system in accordance with claims 1 and 2, wherein the flow passage at the liquid heating chamber constitutes solely a slight resistance to it, from the point of view of a pressure drop.
14. A system in accordance with claim 5, wherein the connecting of said heat sink to said heating elements and the gap between said heat sink to said base (6186) reduce the heat transfer from said heating elements to said base.
15. A system in accordance with claim 14, wherein transfer of heat from said heat sink to said base (6186) increases the thermal efficiency of main assembly 6104.
16. A heated liquid discharge system comprising:  
a main assembly which provides liquid heating and includes electrical and liquid flow control functionalities;

pump and a liquid inflow conduit supplying liquid from a liquid reservoir to said main assembly; and

a liquid outflow conduit supplying fluid to at least one sprayer located at at least one location on a motor vehicle.

said main assembly comprising a liquid heating chamber communicating with said liquid inflow conduit and said liquid outflow conduit, forming a volume for said liquid between principal housing portion (6160) to cylindrical outer sleeve 6184; and

additional volume formed for said liquid between cylindrical outer sleeve 6184 to said heat sinks; and

providing volume for said liquid inside said heat sinks.

17. A system in accordance with claim 16, wherein a flowing liquid enters said first volume and subsequently flows to the other two volumes. Actually, splitting of said liquid flows is taking place.
18. A system in accordance with claim 17, wherein the main liquid flow occurs between principal housing portion (6160) to cylindrical outer sleeve 6184
19. A system in accordance with any of claims 16 to 18, wherein the temperature gradient between said three volumes is such that the temperature at said outer volume is low and causes only small heat loss of said liquid, thus increasing said thermal efficiency of said main assembly (6104).
20. A system in accordance with any of claims 16 to 19, wherein said system is operated without driven flow.
21. A system in accordance with any of claims 16 to 19, wherein said system is operated with liquid flow driven in it.
22. A heated liquid discharge system comprising:  
a main assembly which provides liquid heating and includes electrical and liquid flow control functionalities;

pump and a liquid inflow conduit supplying liquid from a liquid reservoir to said main assembly; and

a liquid outflow conduit supplying fluid to at least one sprayer located at at least one location on a motor vehicle.

Said main assembly comprising a liquid heating chamber communicating with said liquid inflow conduit and said liquid outflow conduit

Base (6186) of said liquid heating chamber; and

An electricity fuse 6390 connected to said base, located outside of said liquid heating chamber.

23. A system in accordance with claim 22, in which a good heat transfer feature exists between said base to said fuse, when said fuse is in mechanical and thermal connection to said base.
24. A system in accordance with claims 22 and 23, wherein said fuse contains soldering material (6396), whose melting temperature is lower than that of an adjacent part.
25. A system in accordance with any of claims 22 to 24, wherein the electric current through the fuse passes through said material characterized by its low melting temperature.
26. A system in accordance with any of claims 22 to 25, wherein – when said fuse is heated to a temperature above said melting temperature of said soldering material, said soldering material melts, and at least part of it breaks away from said fuse. This melting occurrence causes the desired cut off of said electric current through said fuse.
27. A system in accordance with claim 26, wherein said fuse is a one-time fuse that cuts off said electric current to at least one of said heating elements. This occurrence is – as said, a one-time and final occurrence.
28. A heated liquid discharge system comprising:  
a main assembly which provides liquid heating and includes electrical and liquid flow control functionalities;  
pump and a liquid inflow conduit supplying liquid from a liquid reservoir to said main assembly; and

a liquid outflow conduit supplying fluid to at least one sprayer located at at least one location on a motor vehicle.

Said main assembly comprising a liquid heating chamber communicating with said liquid inflow conduit and said liquid outflow conduit contains a leaky one way valve (5660); and wherein ball 5752 was removed from said leaky one way valve.

29. A system in accordance with claim 28, wherein – by eliminating said ball, the operation of said leaky one-way valve was canceled and thus free flow is enable through it in both directions.
30. A heated liquid discharge system comprising:  
a main assembly which provides liquid heating and includes electrical and liquid flow control functionalities;  
pump and a liquid inflow conduit supplying liquid from a liquid reservoir to said main assembly; and  
a liquid outflow conduit supplying fluid to at least one sprayer located at at least one location on a motor vehicle.  
Said main assembly comprising a liquid heating chamber communicating with said liquid inflow conduit and said liquid outflow conduit; and  
an additional liquid input opening was added to said main assembly, wherein at its extension it is connected directly to said leaky one way valve assembly.
31. A system in accordance with claim 30, wherein – using a suitable cover, said entrance opening that at its extension is connected directly to said leaky one way valve assembly at said main assembly was closed.  
By using said cover to close said opening, a condition was formed in which the activity of said main assembly would be such that it performs the activity of said leaky one way valve at its normal operational mode.
32. A system in accordance with claim 30, wherein a bi-directional valve is connected to one liquid entrance opening and to two liquid exit openings. Said two liquid exit openings were connected to two said entrance openings of said main assembly, namely:  
First input (entrance) opening that its extension is the regular liquid input opening is connected to said the leaky one way valve (5660).

and a second input (entrance) opening –that at its extension is directly connected to said the leaky one way valve (5660).

33. A system in accordance with claim 32, wherein said leaky one way valve of said main assembly is set to lead the liquid flow to an opening, such that it by-passes said the leaky one way valve (5660). It is connected on its other opening to said second input opening – directly to leaky one way opening. The operation of said one way leaky valve is restricted, with the outcome that its liquid can by-pass said the leaky one way valve by flowing through the second entrance input opening.
34. A system in accordance with claim 32. wherein said faucet at said main assembly is adjusted to drive the liquid flow to said first entrance opening – the one that at its extension is directly connected to second input opening, namely the regular liquid entrance to said the leaky one way valve. Thus the full the leaky one way valve functions are operating.
35. A system in accordance with claims 32 to 34, wherein the functional operation of said main assembly is established in accordance with the setting of said faucet.  
Switching over said faucet (namely, said leaky one way valve) from one state to the other, is a simple operation, conveniently performed by the driver.

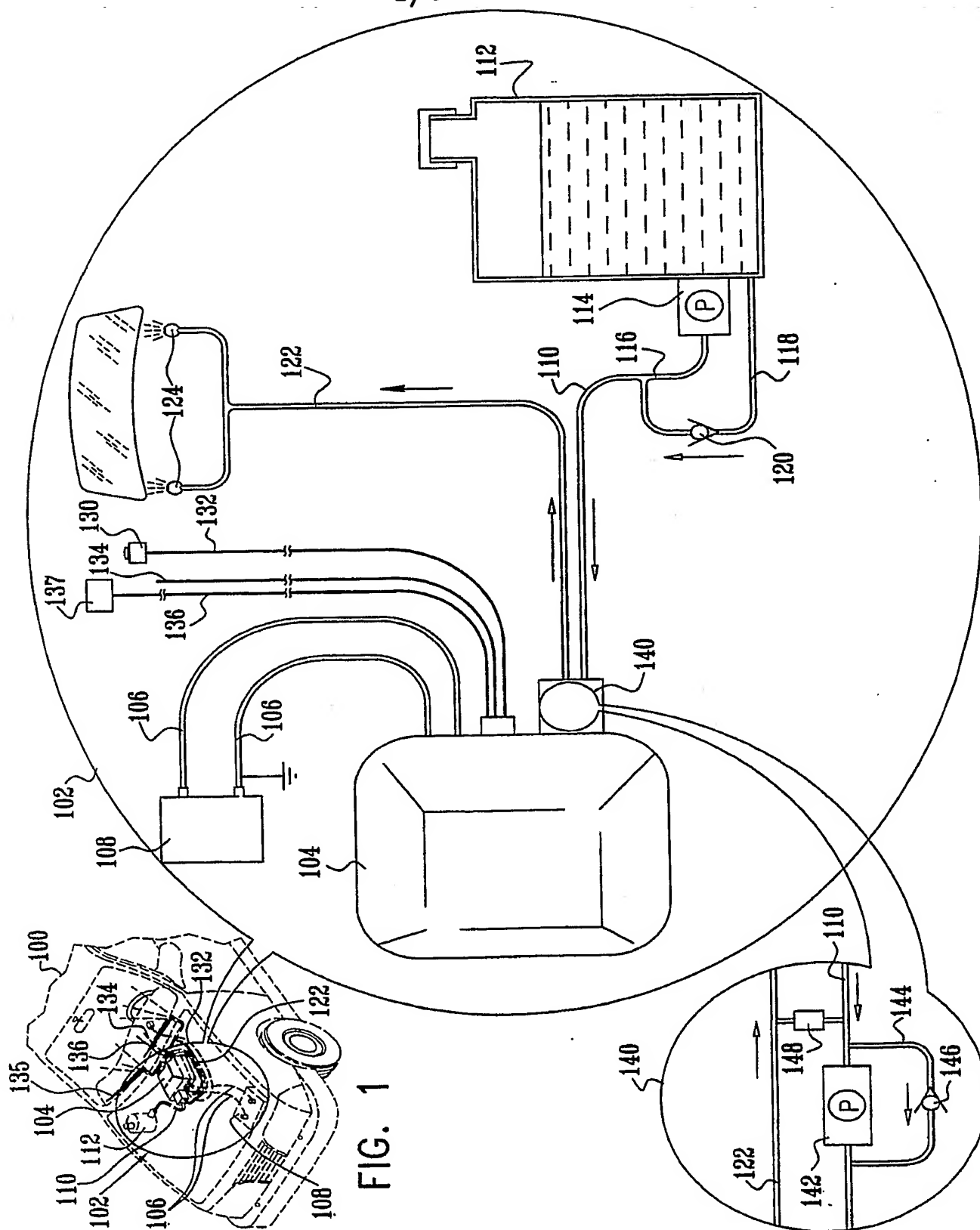
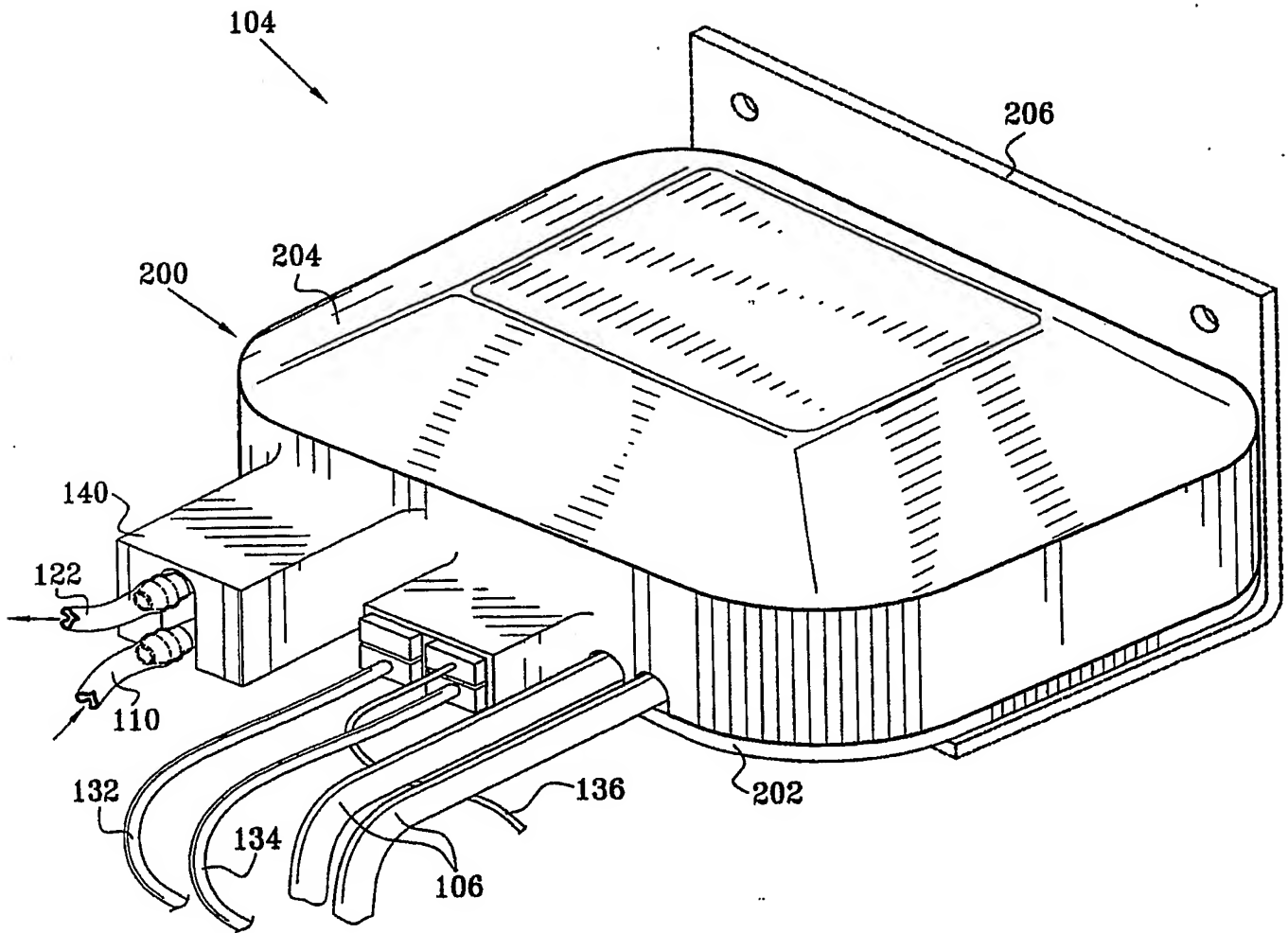


FIG. 2A



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FIG. 2B

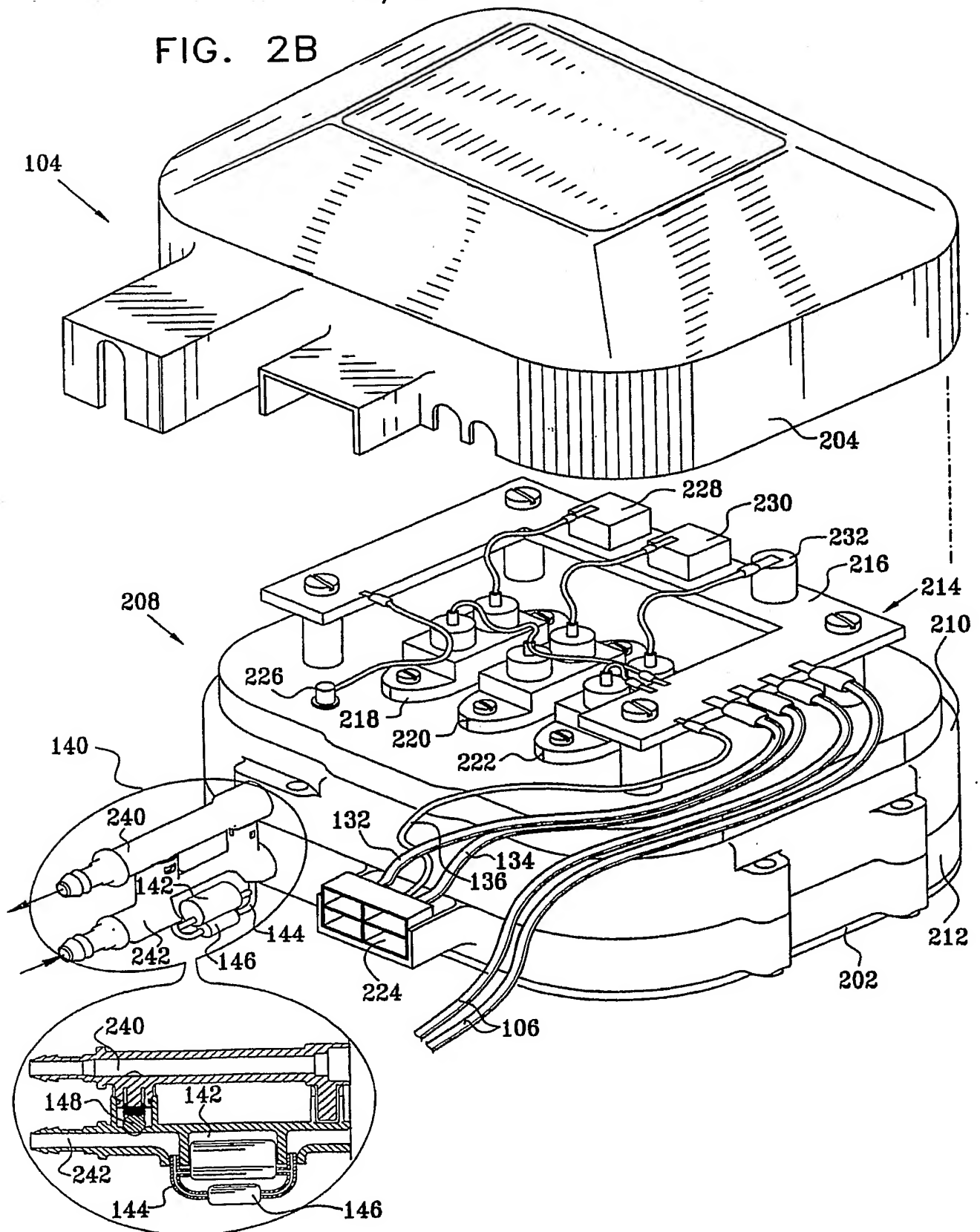


FIG. 3

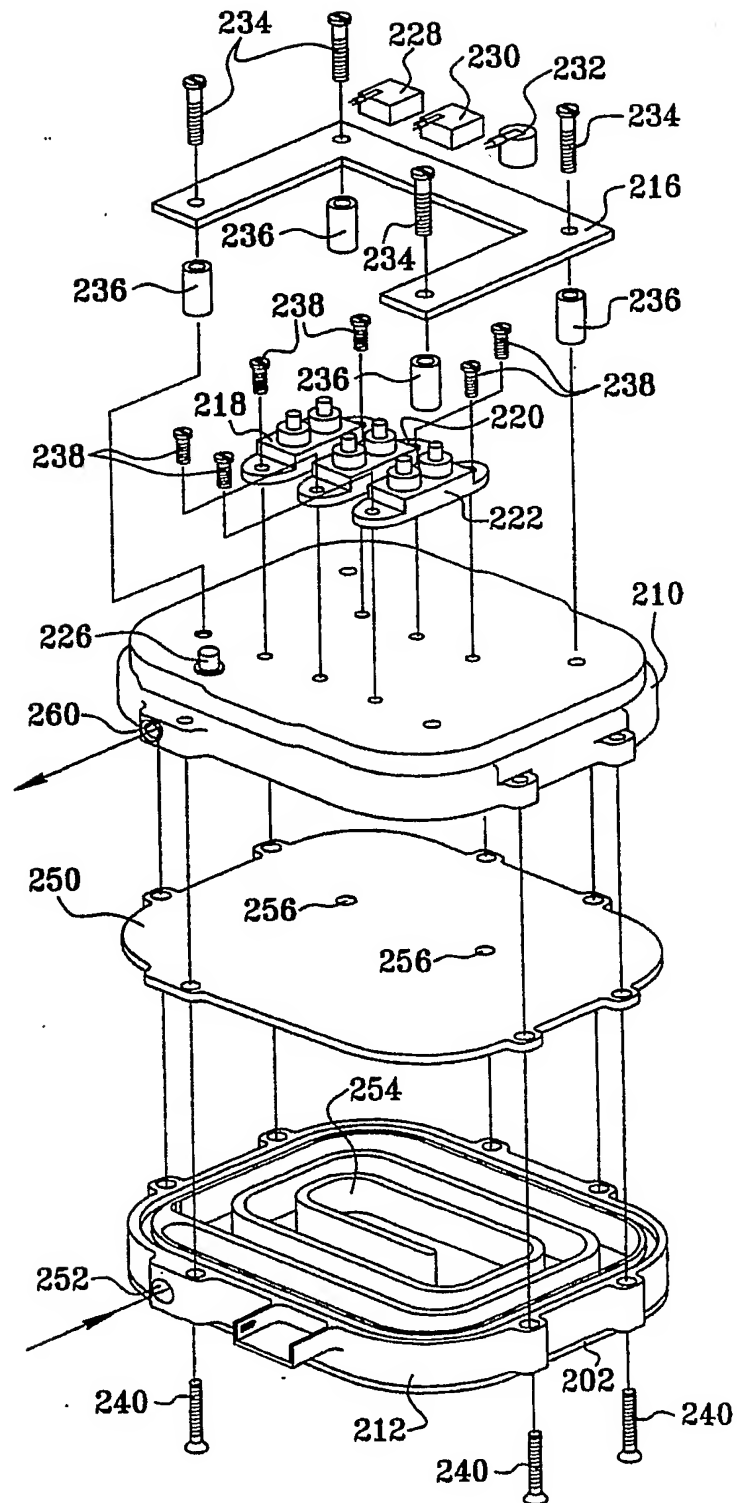


FIG. 4

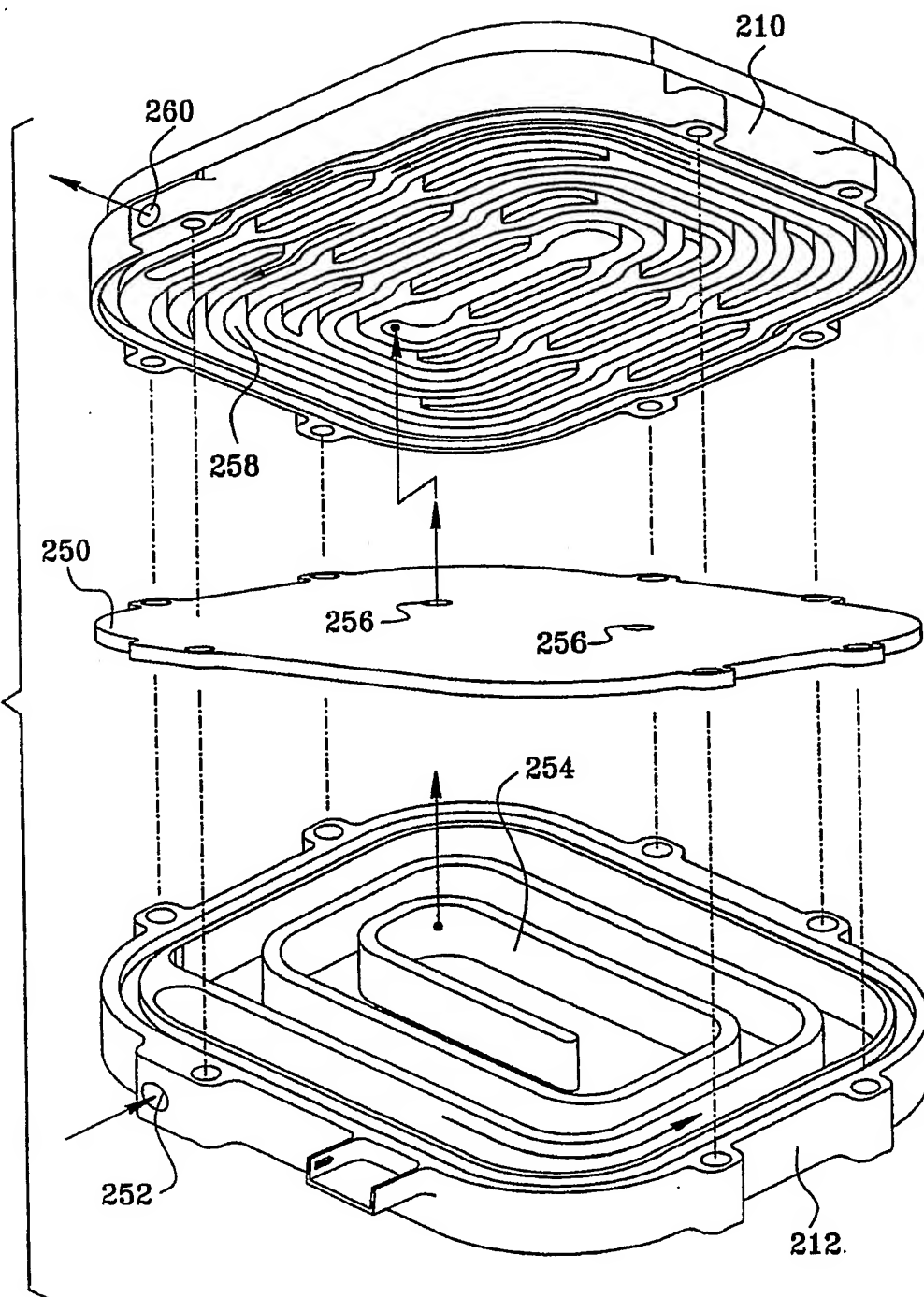
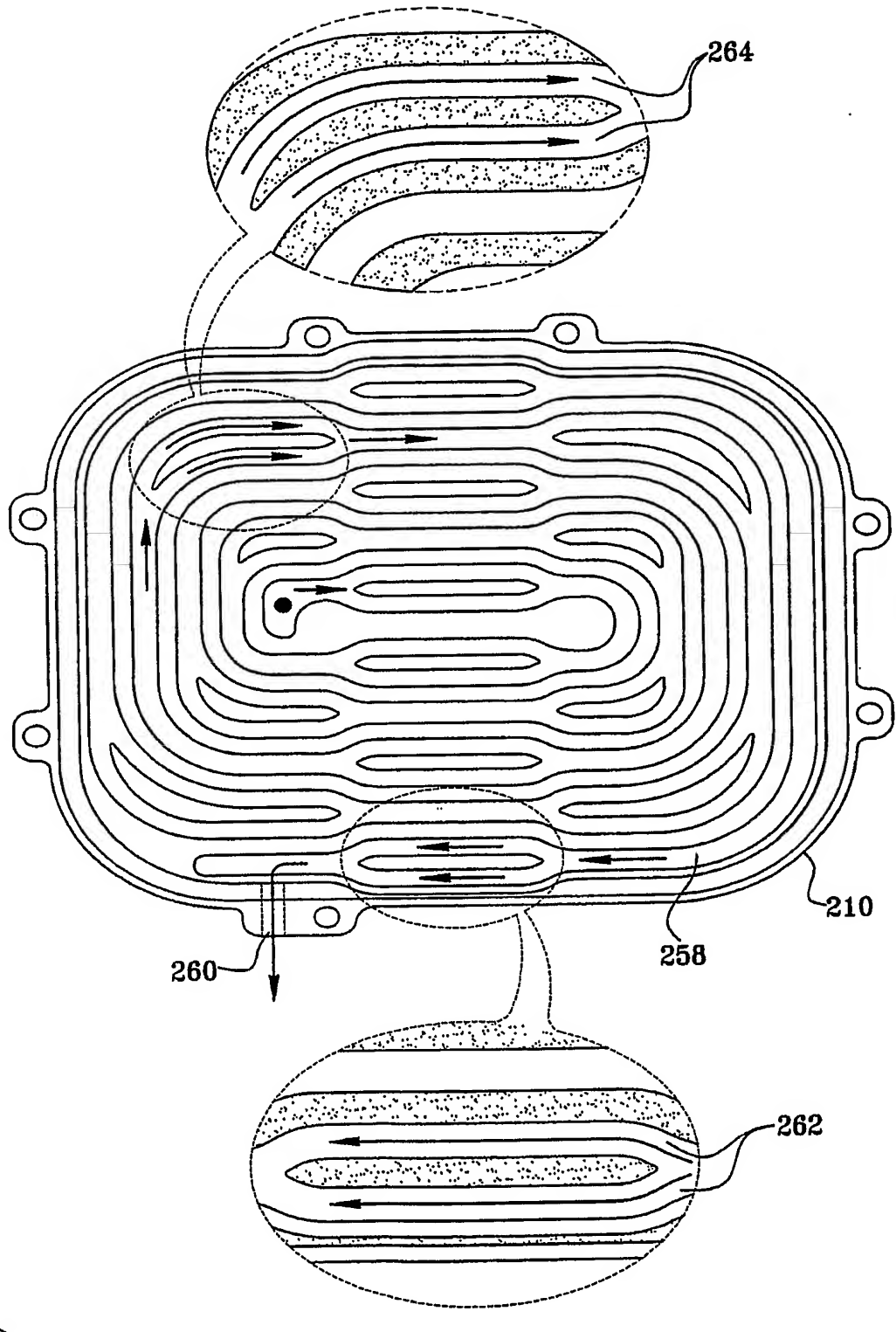


FIG. 5



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FIG. 6A

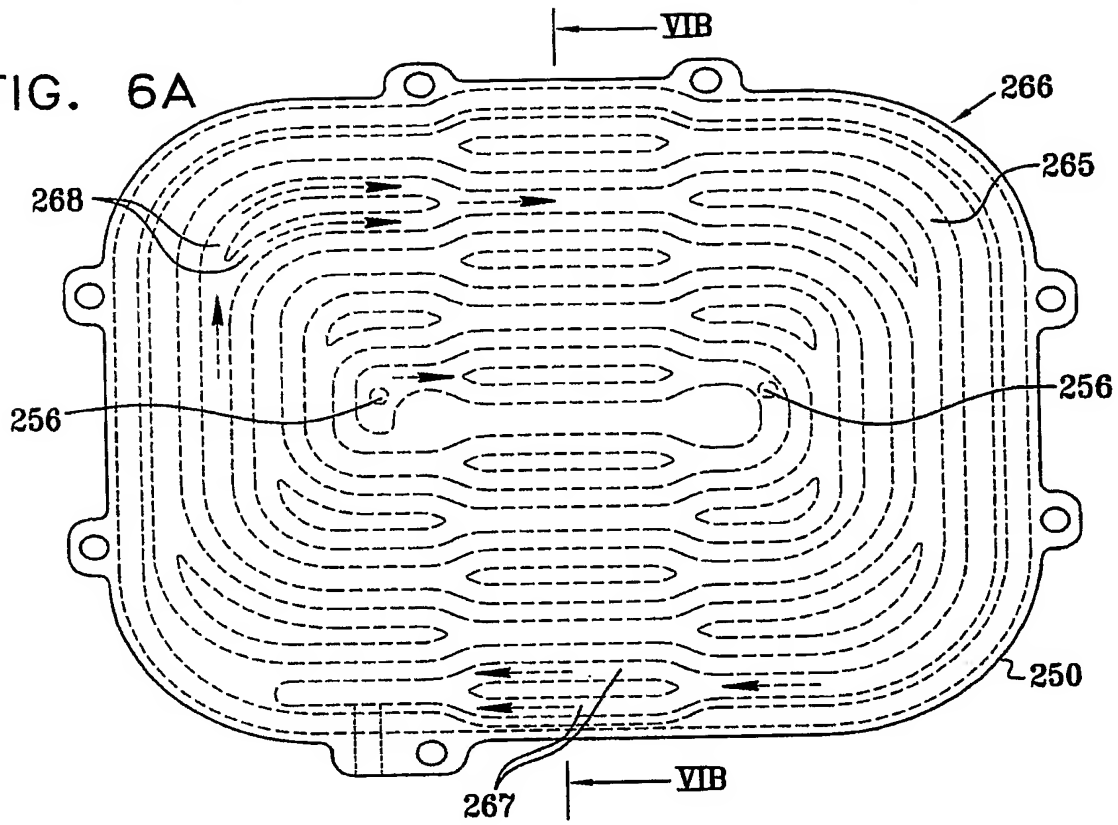


FIG. 6B

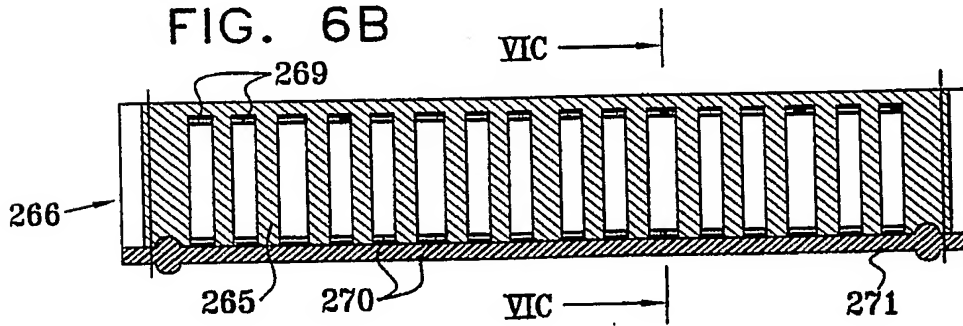


FIG. 6C

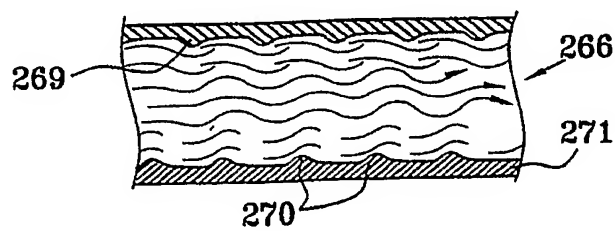


FIG. 7A

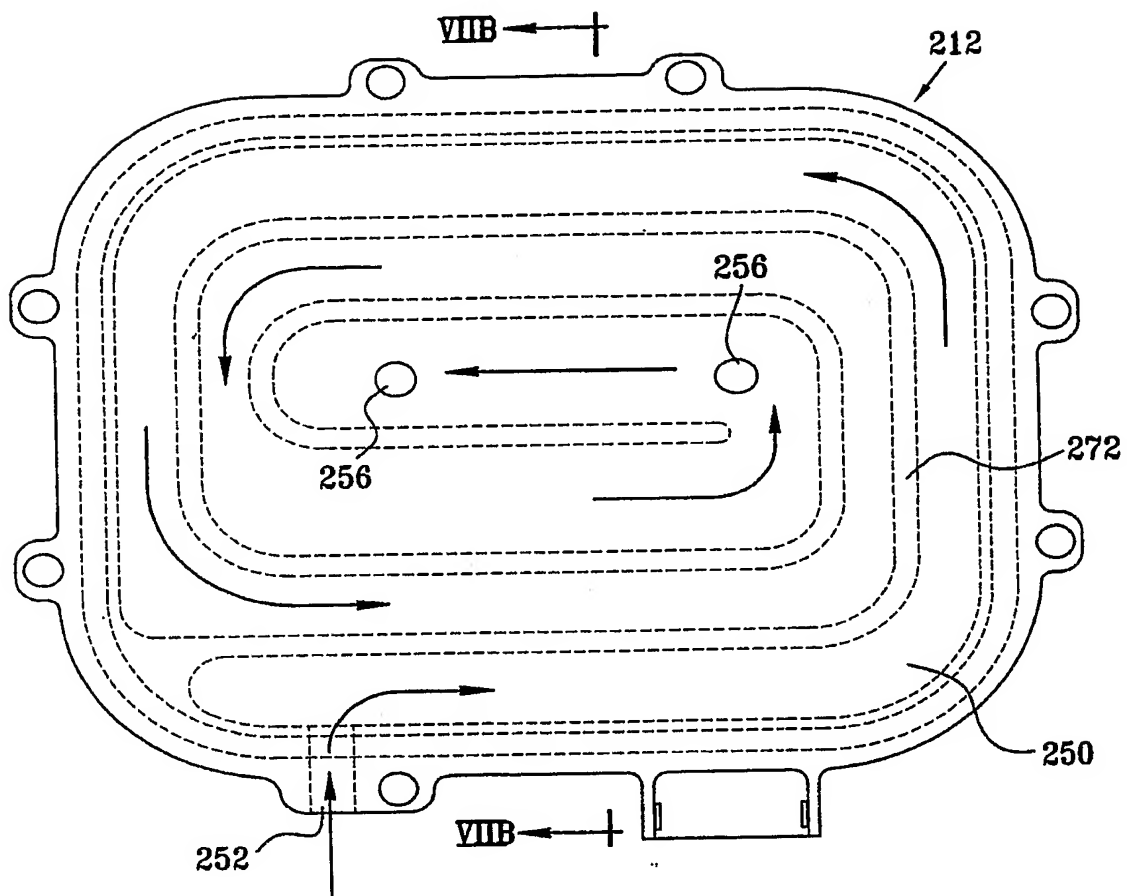


FIG. 7B

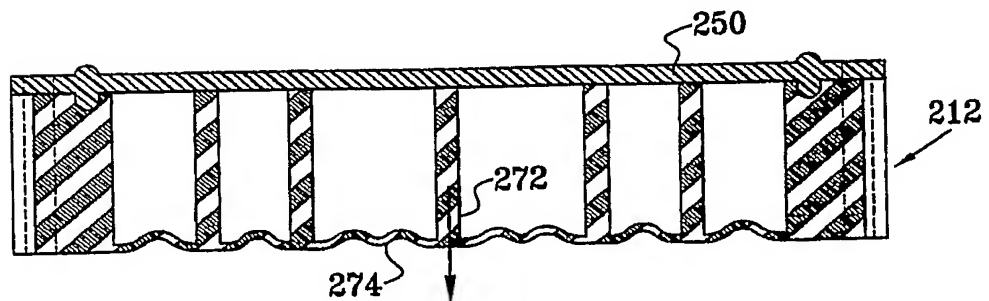


FIG. 8

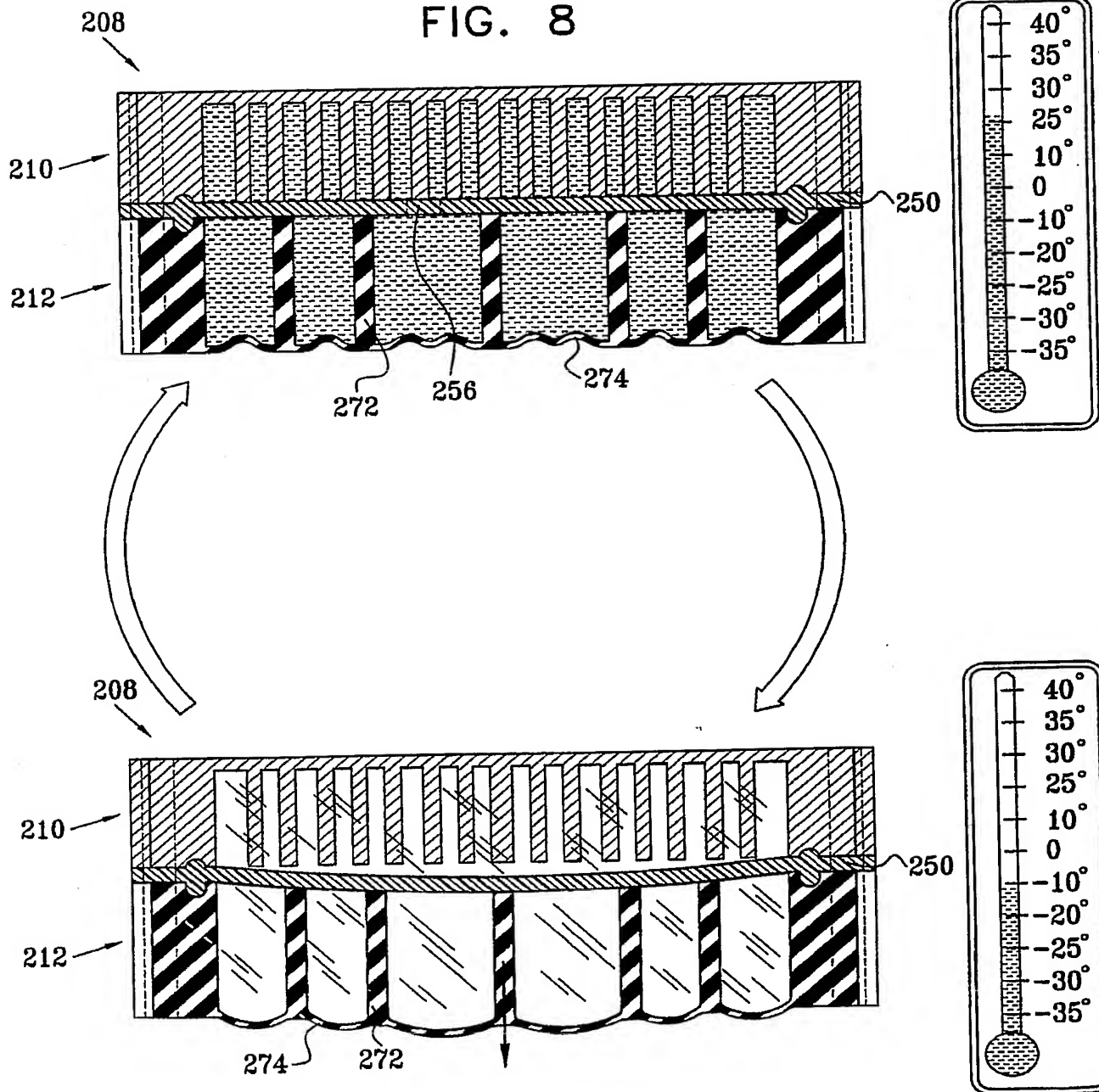


FIG. 9A

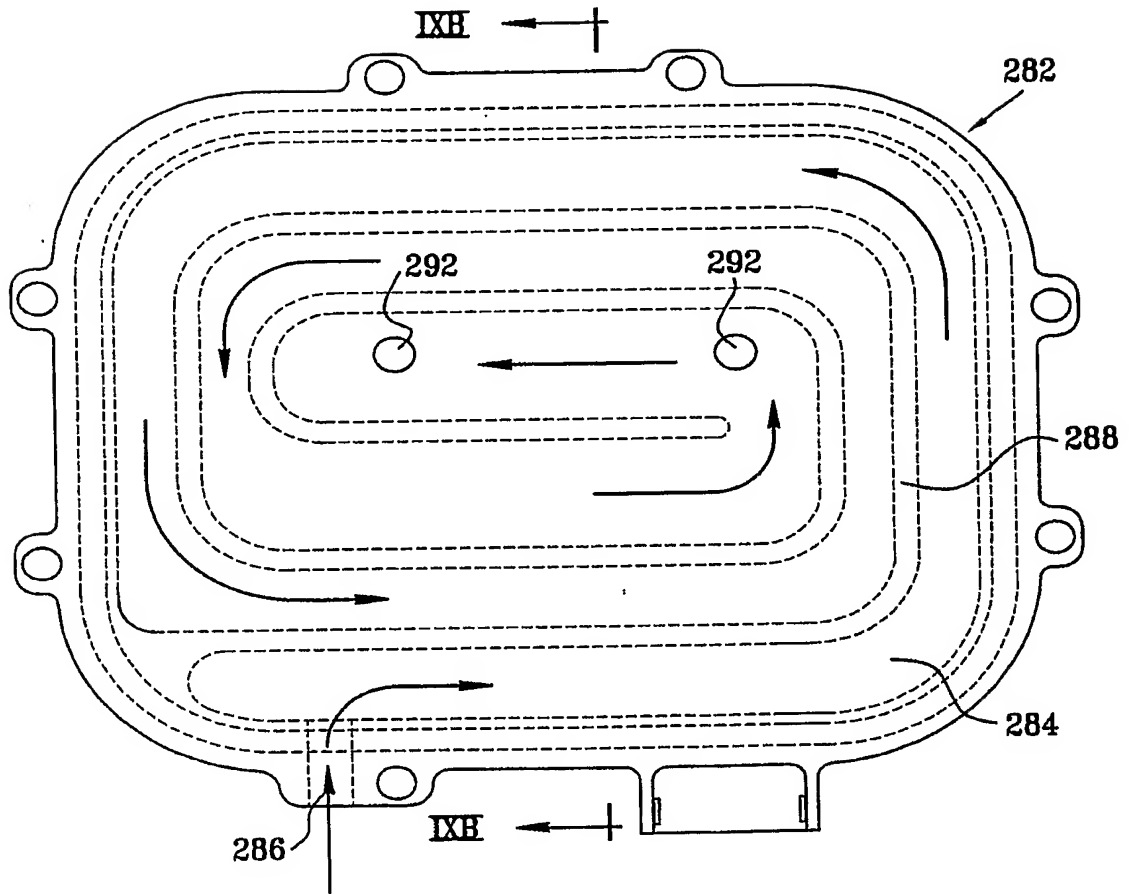


FIG. 9B

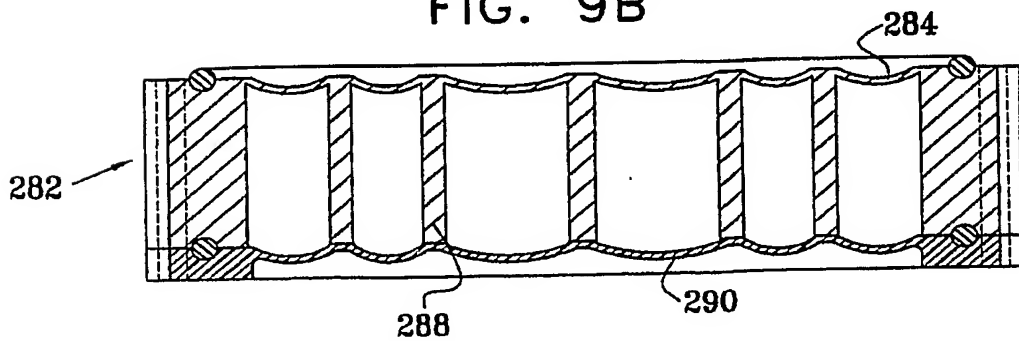
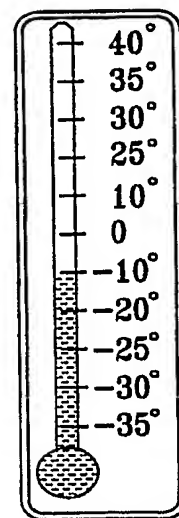
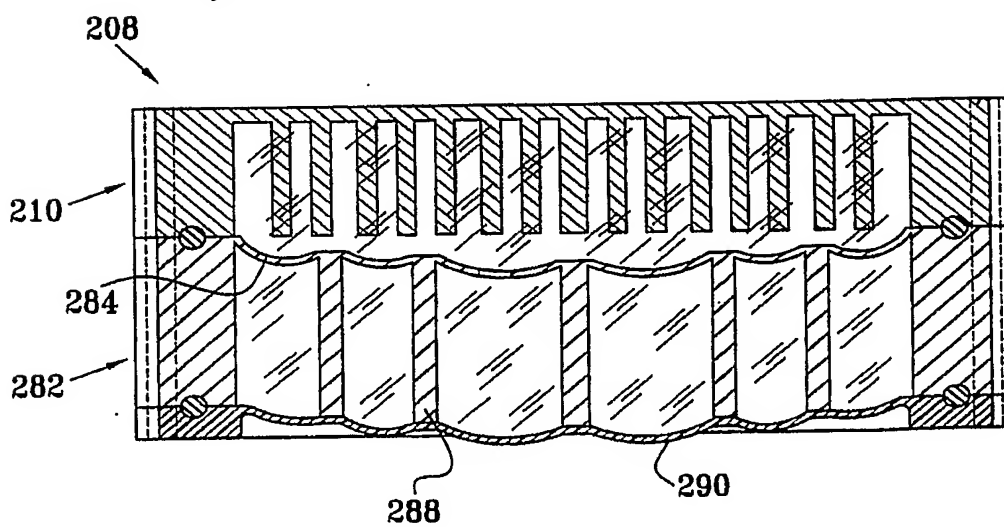
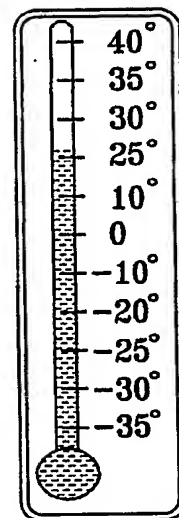
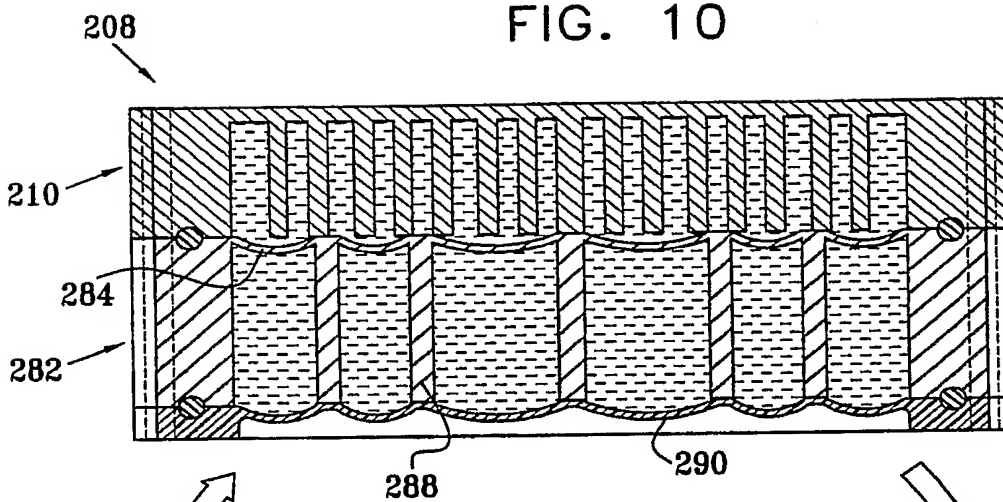


FIG. 10



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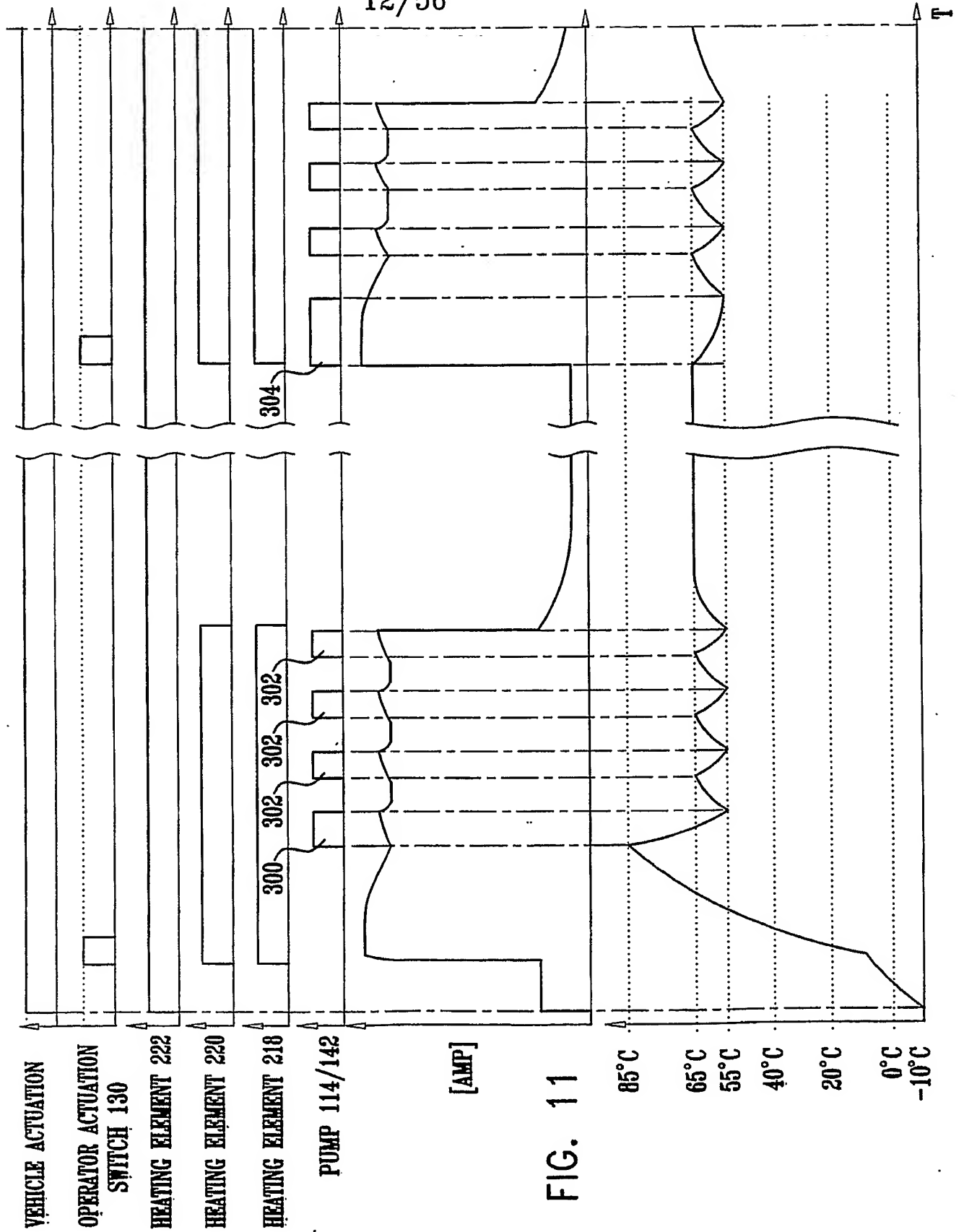


FIG. 11

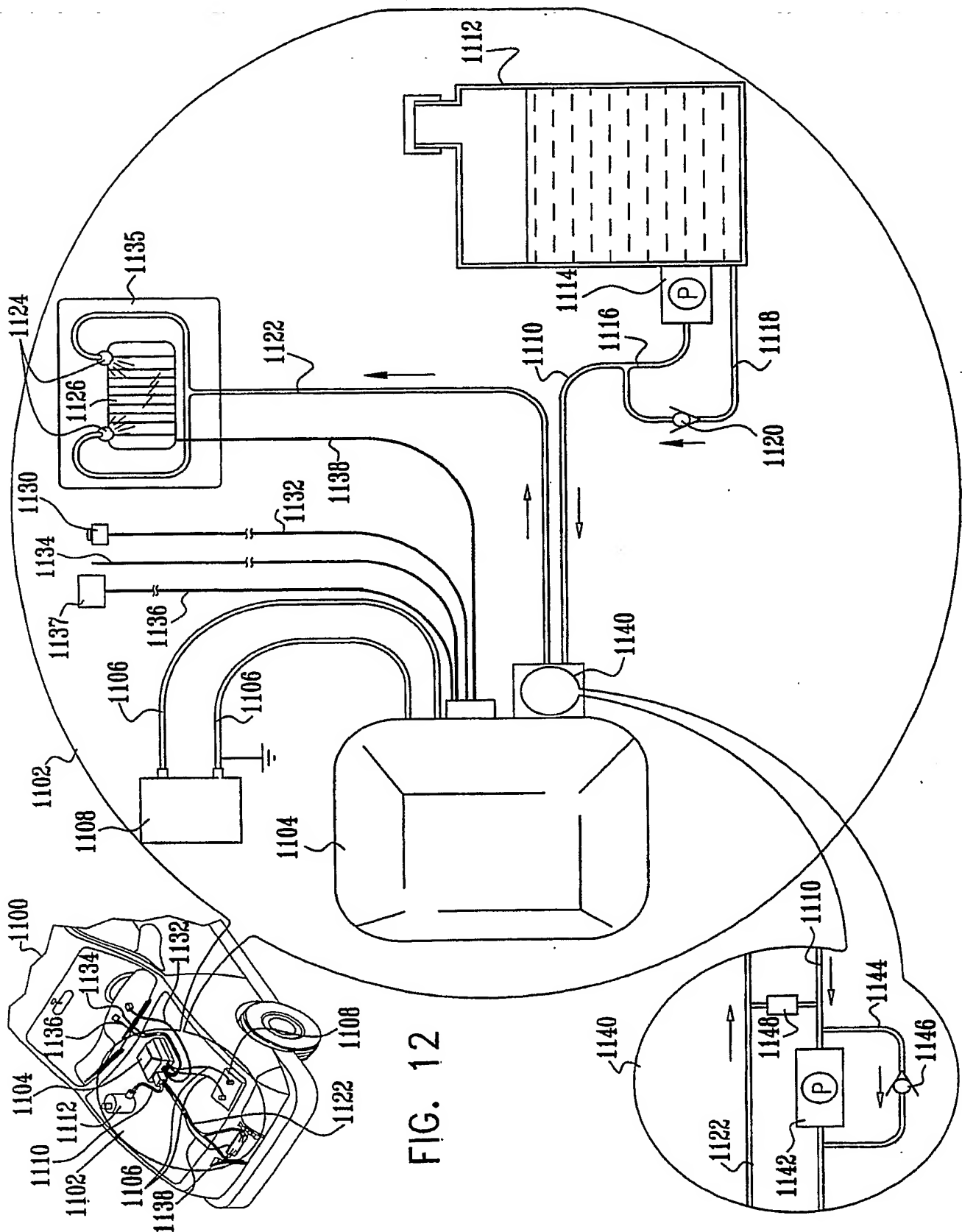


FIG. 12

FIG. 13A

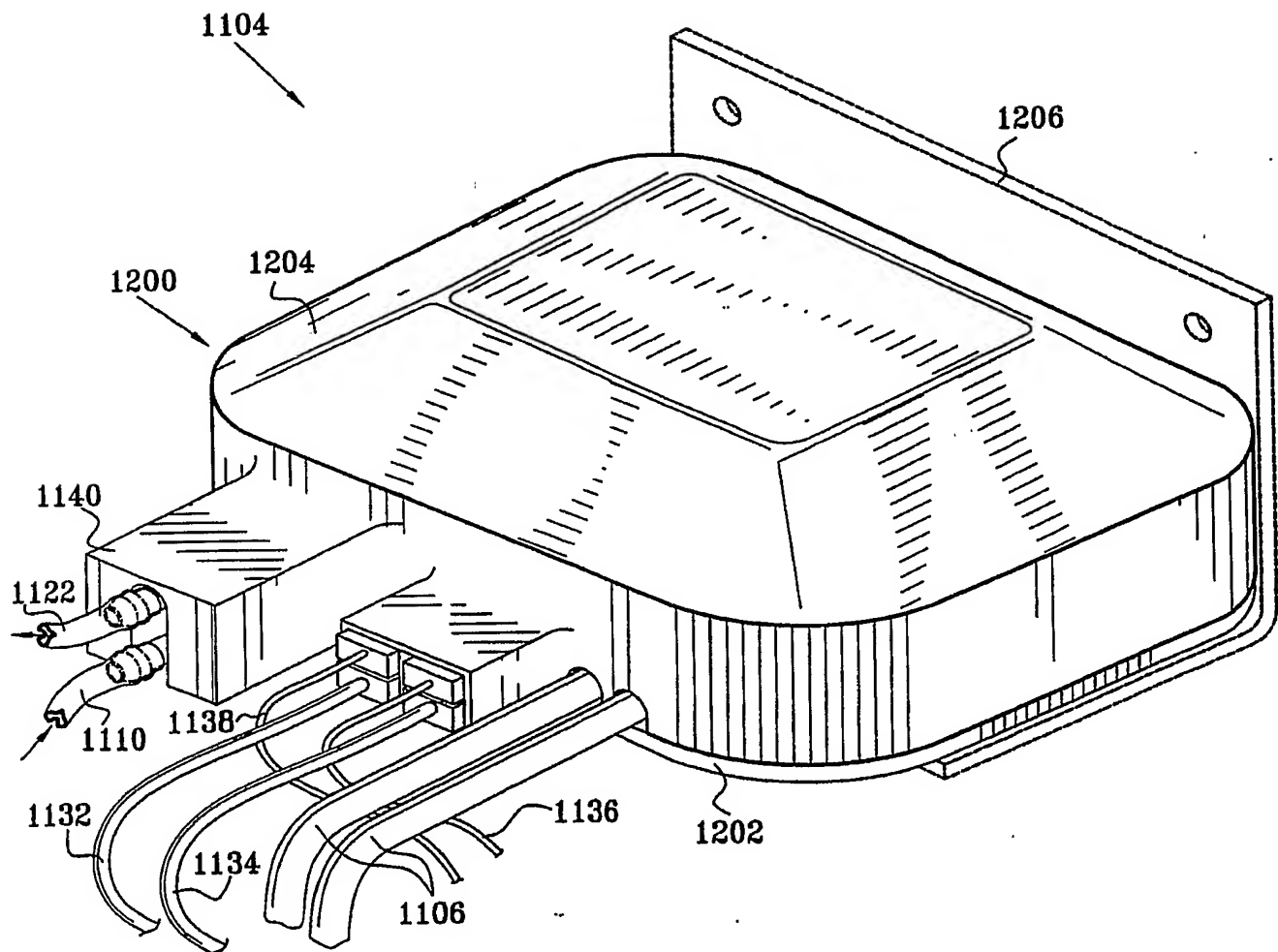


FIG. 13B

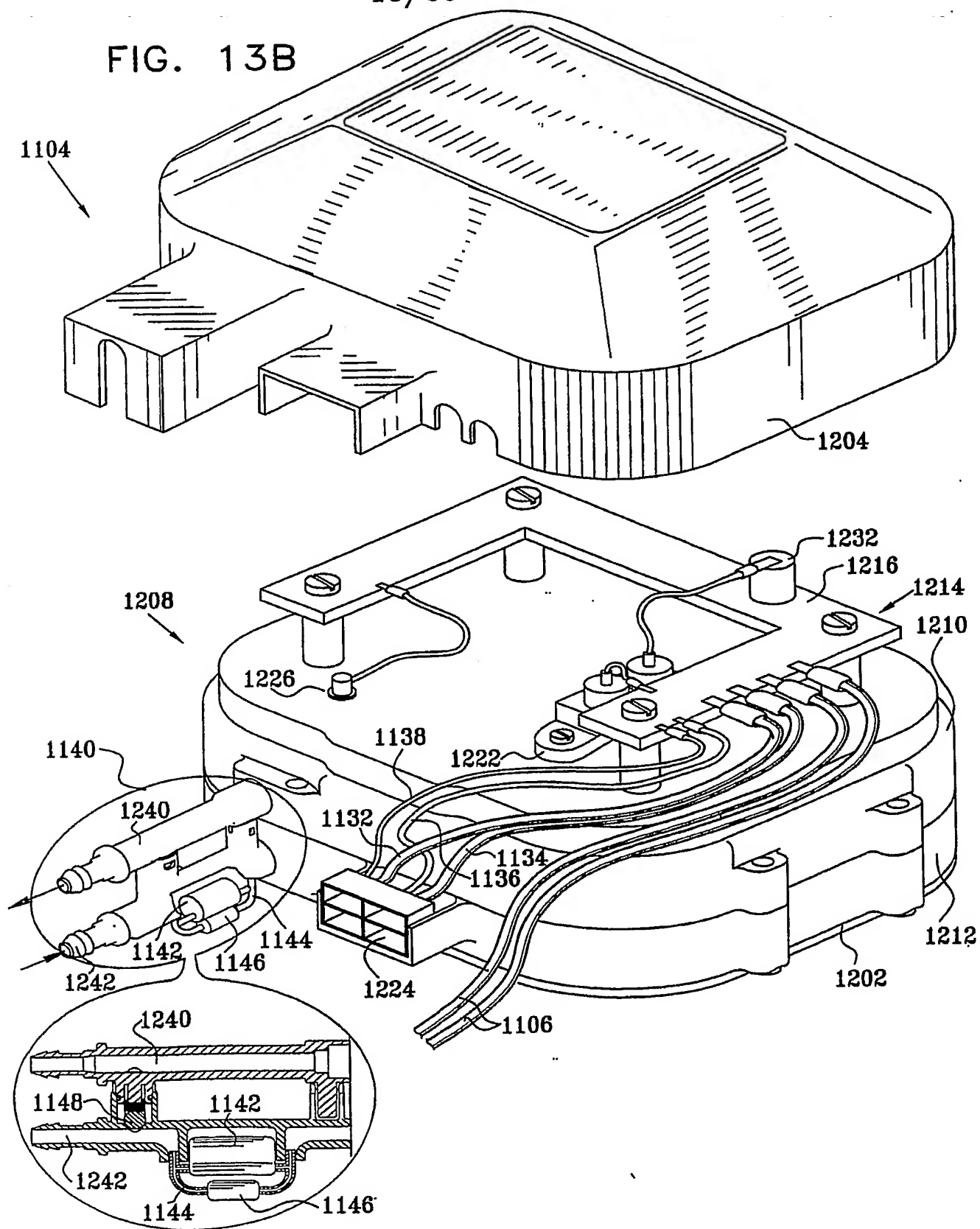
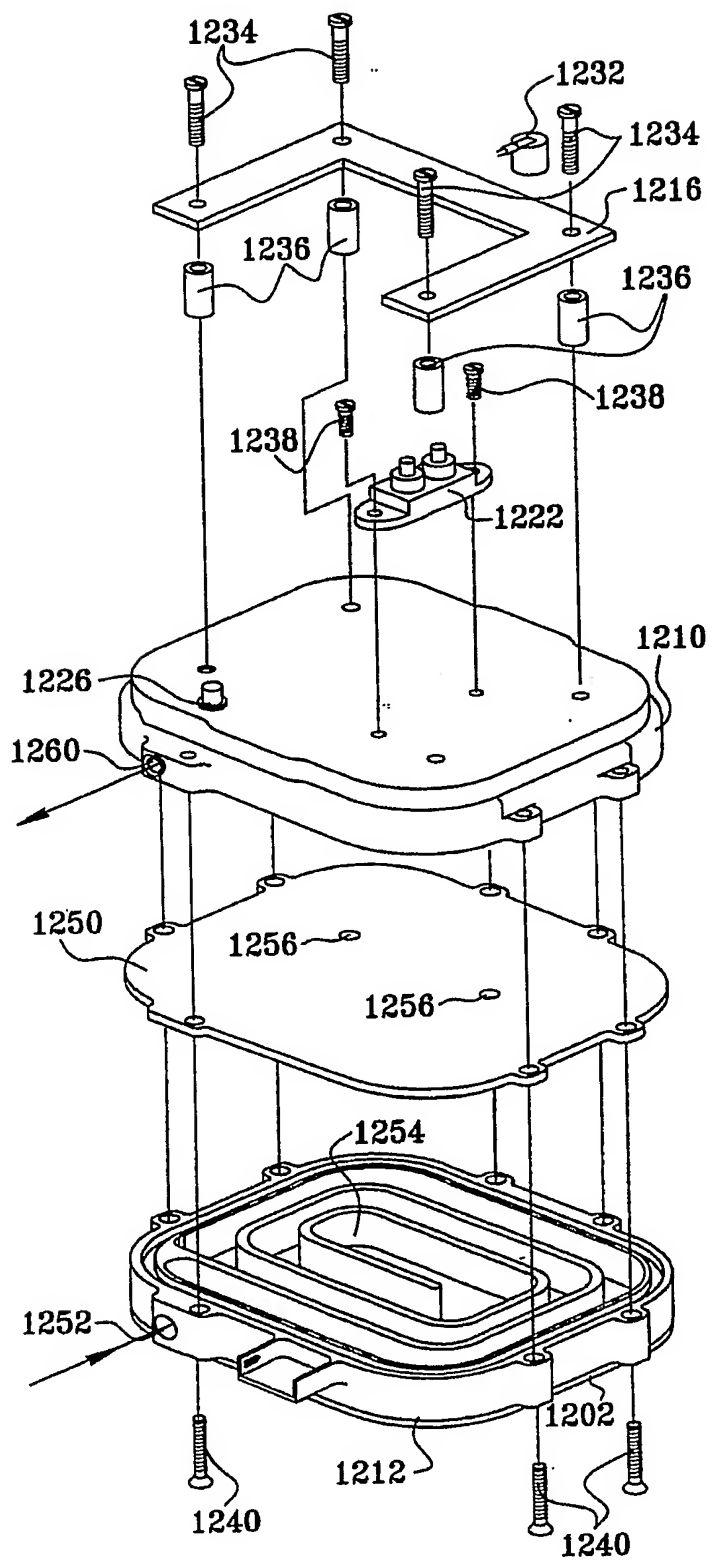


FIG. 14



VEHICLE RADAR  
ACTUATION  
SWITCH 1130

HEATING  
ELEMENT  
1222

DEPOSITS

AGC

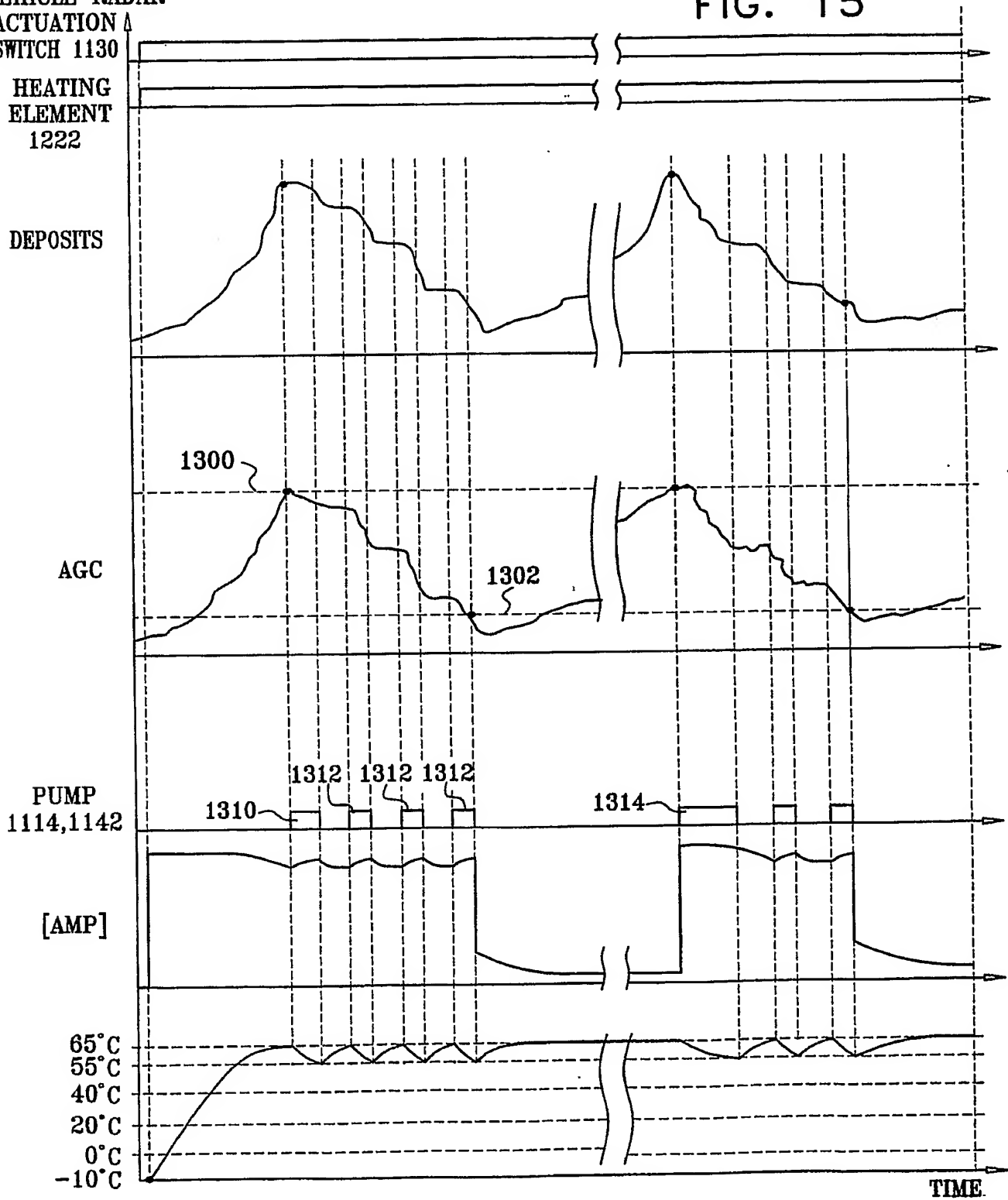
PUMP  
1114,1142

[AMP]

65°C  
55°C  
40°C  
20°C  
0°C  
-10°C

FIG. 15

TIME



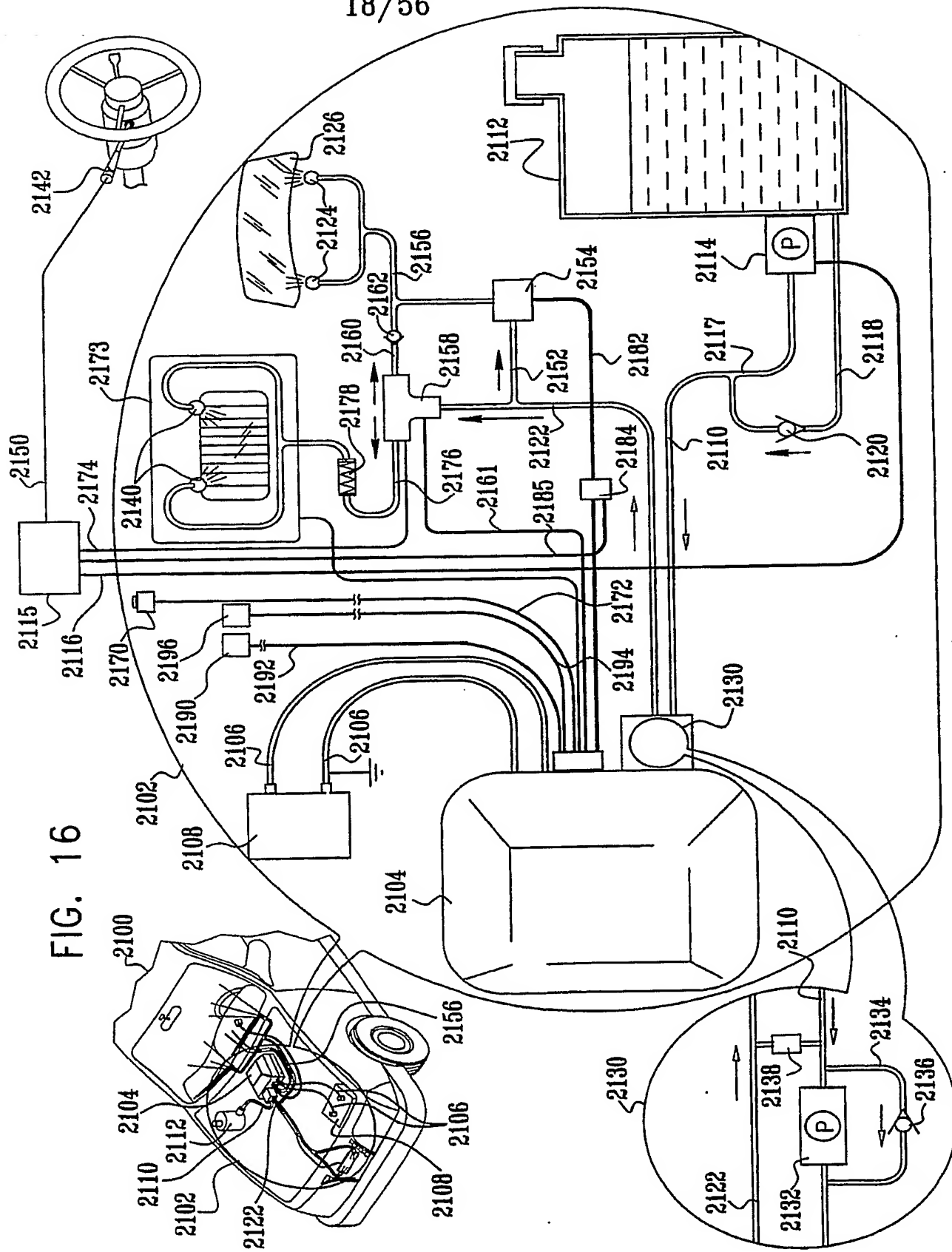
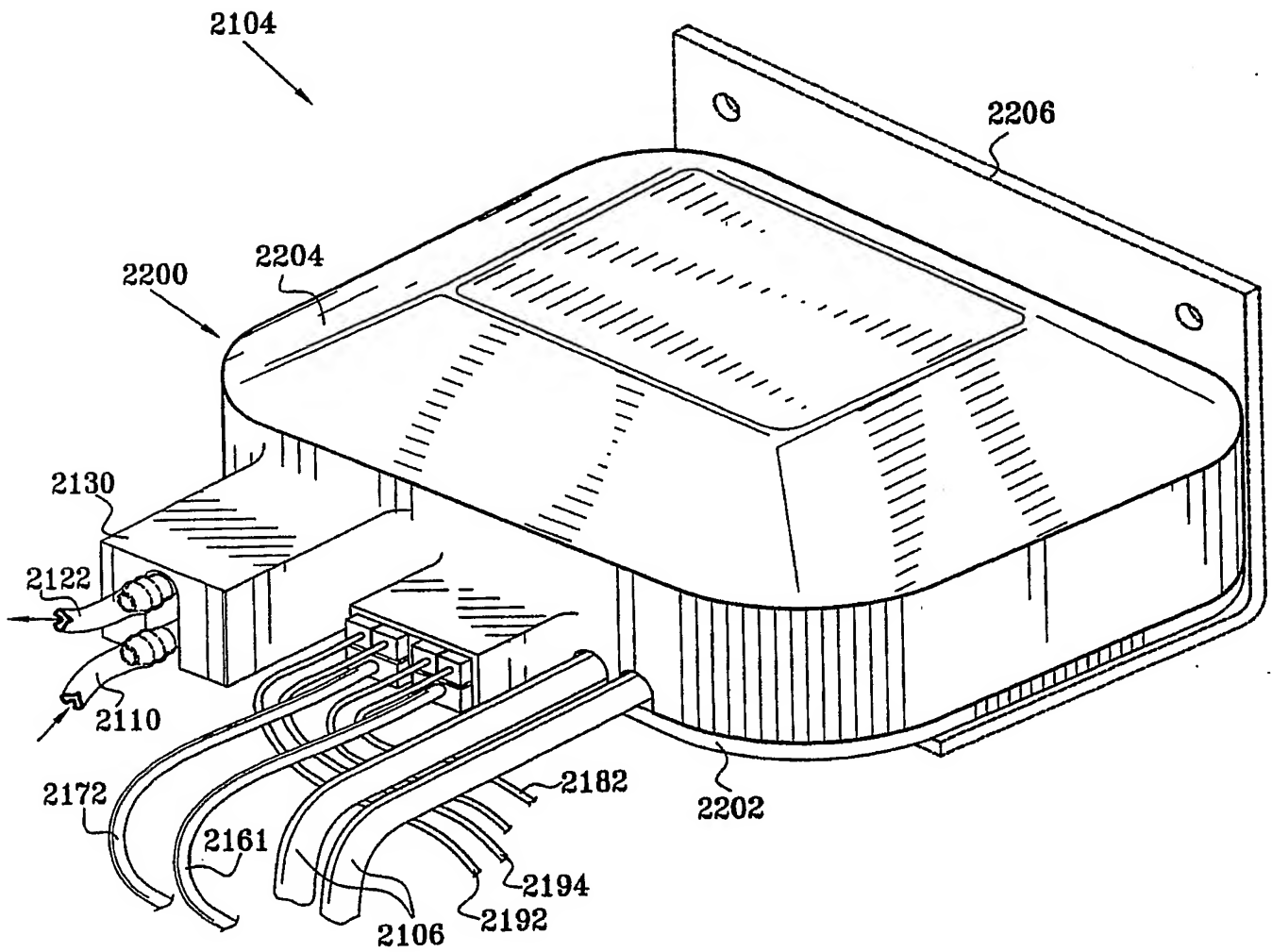


FIG. 16

FIG. 17A



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FIG. 17B

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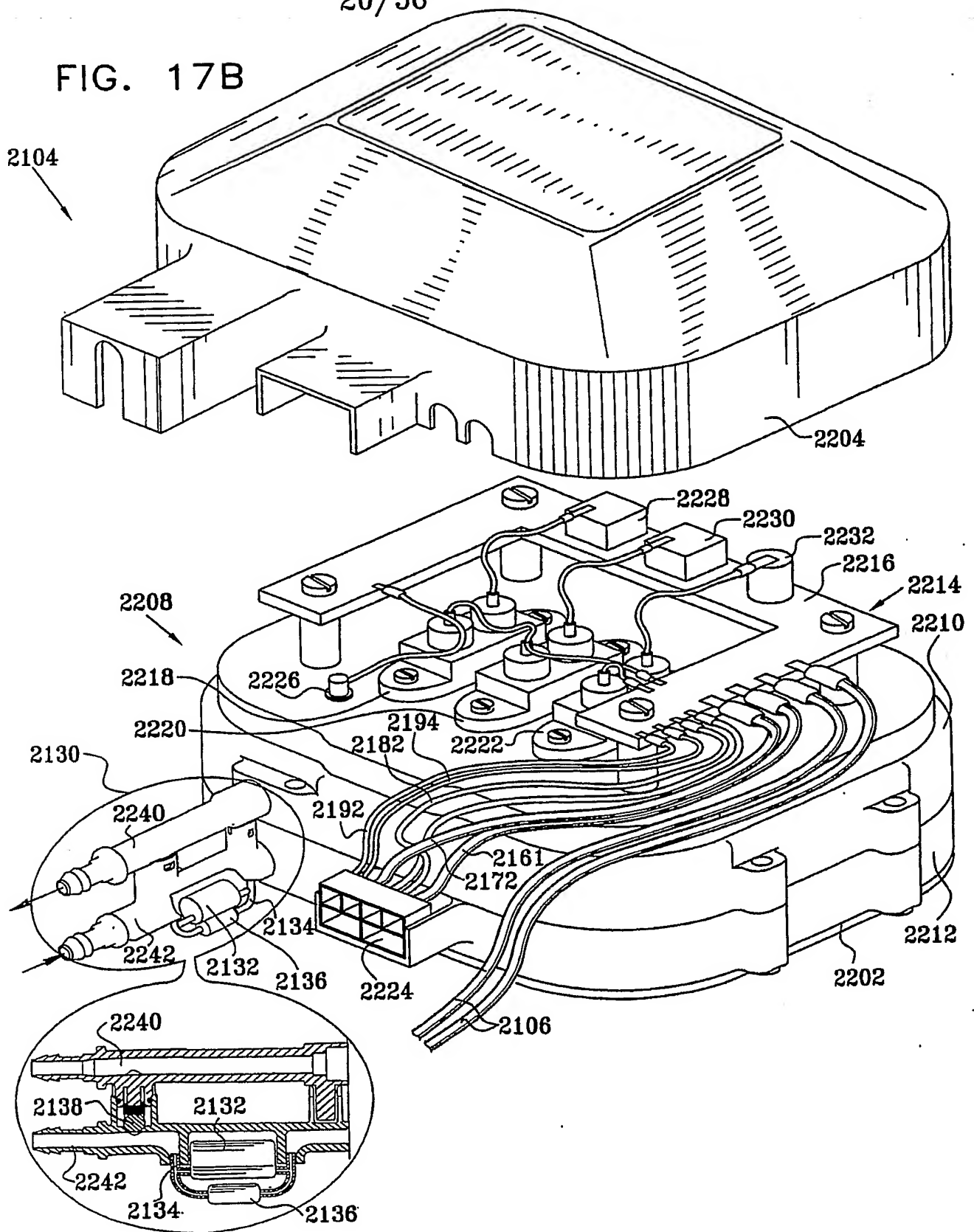
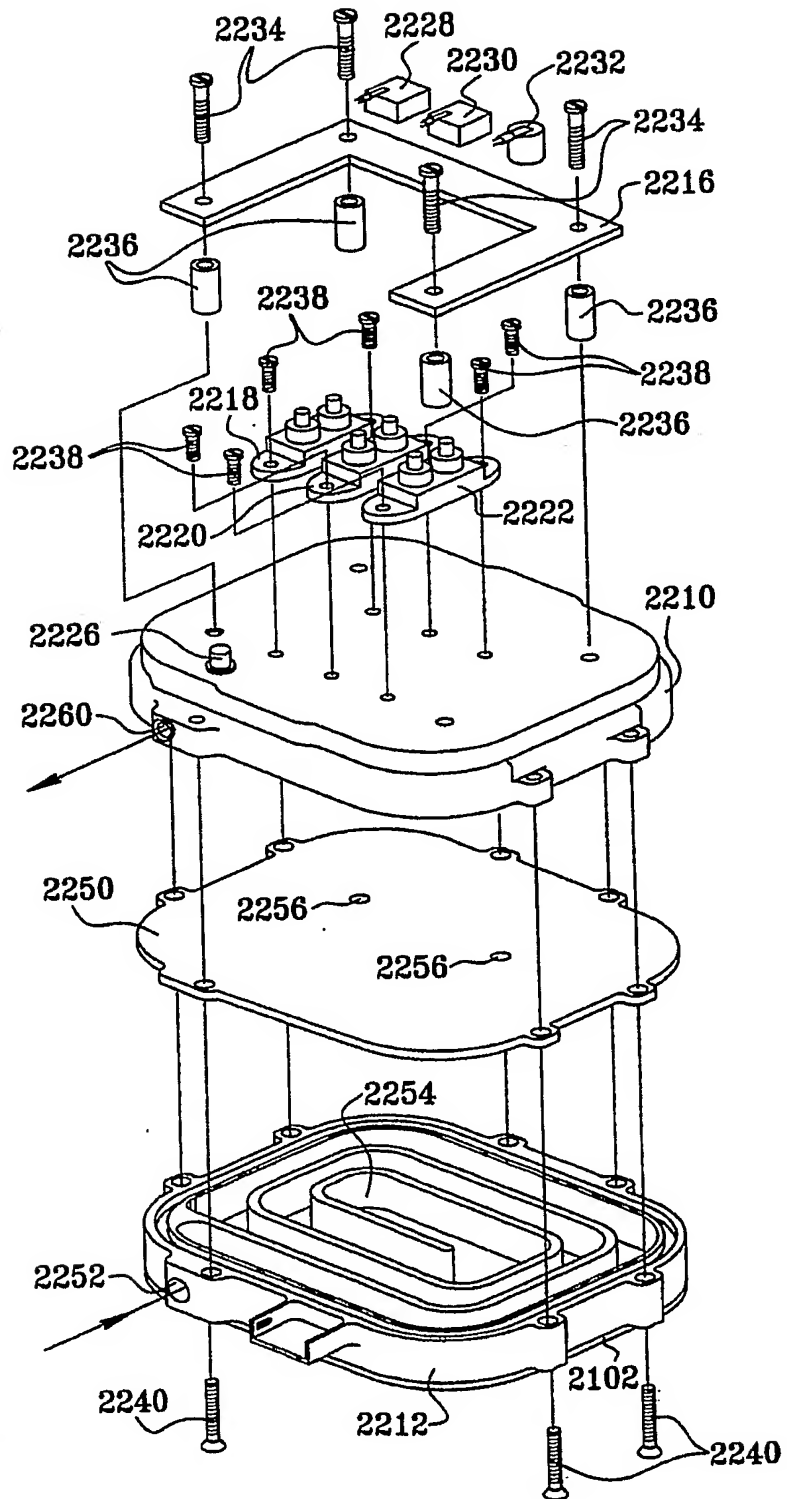
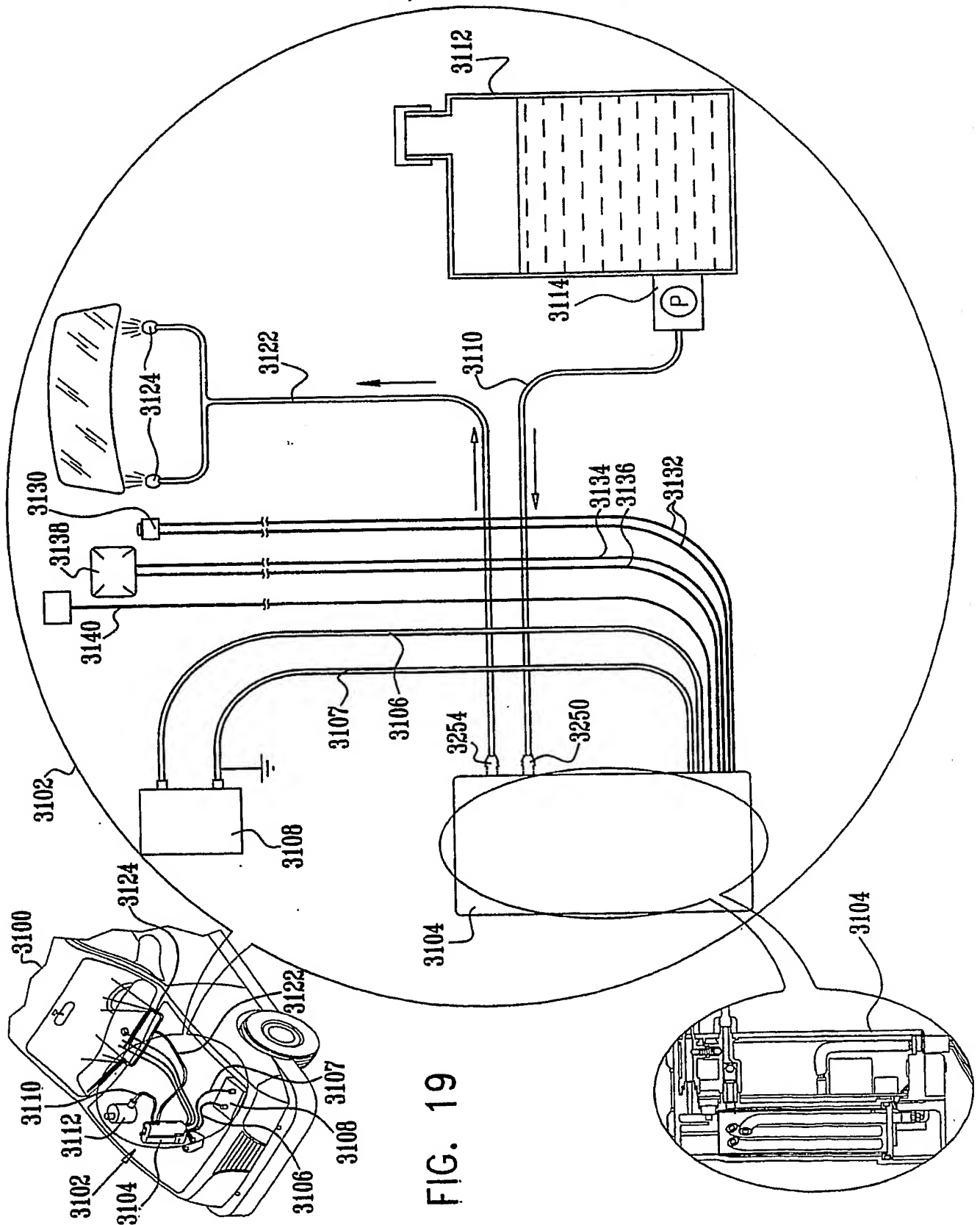


FIG. 18





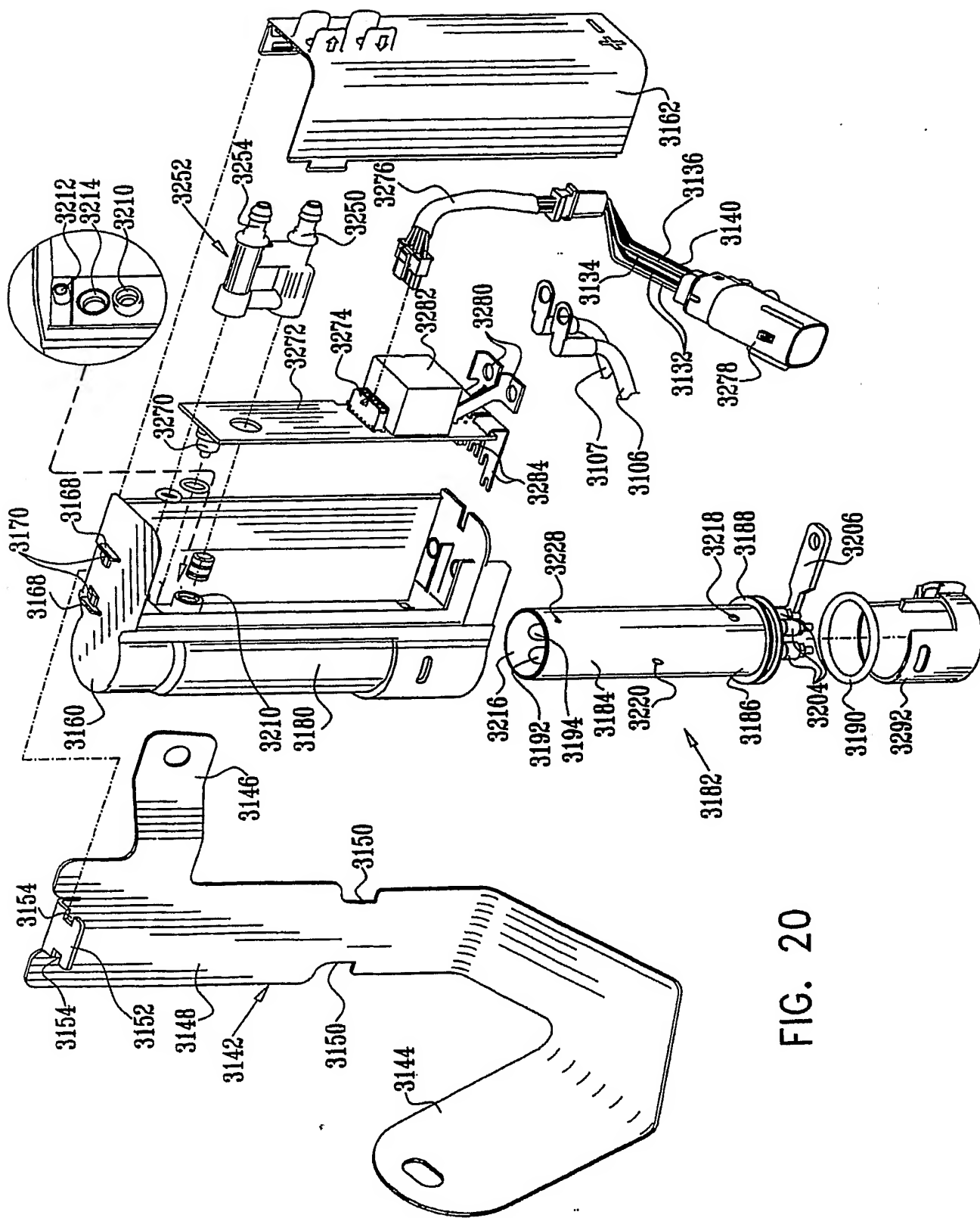
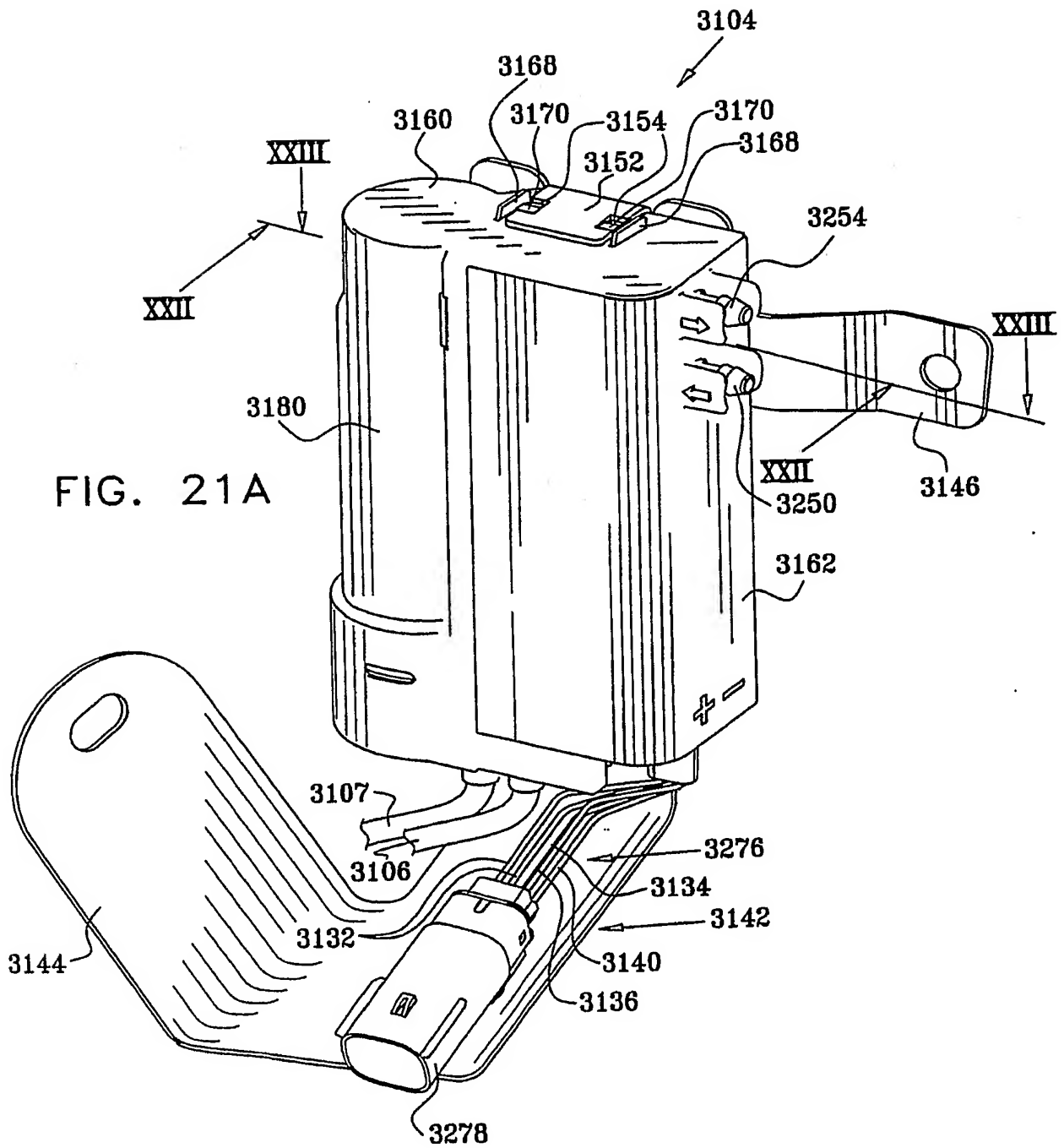
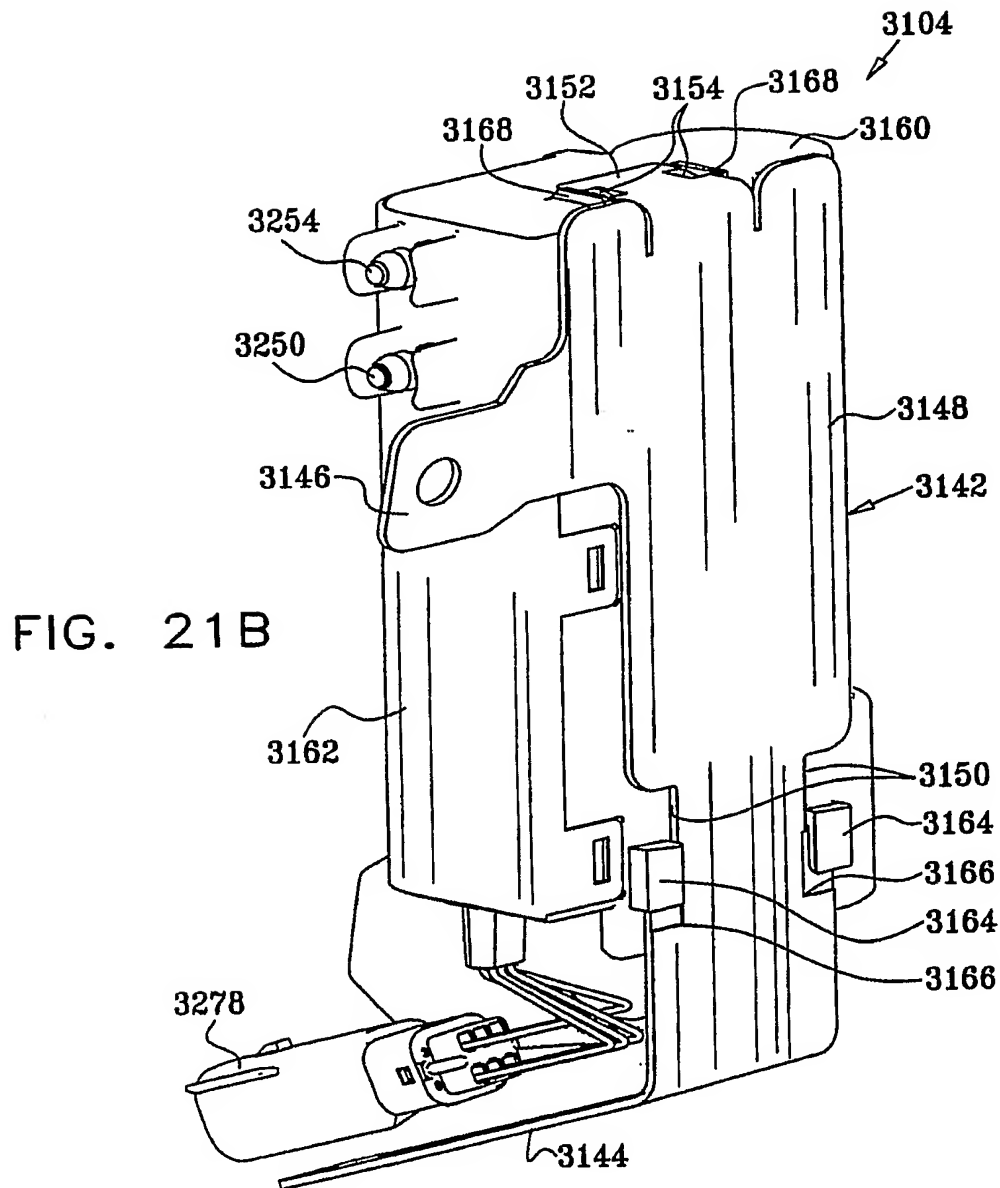


FIG. 20





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FIG. 22

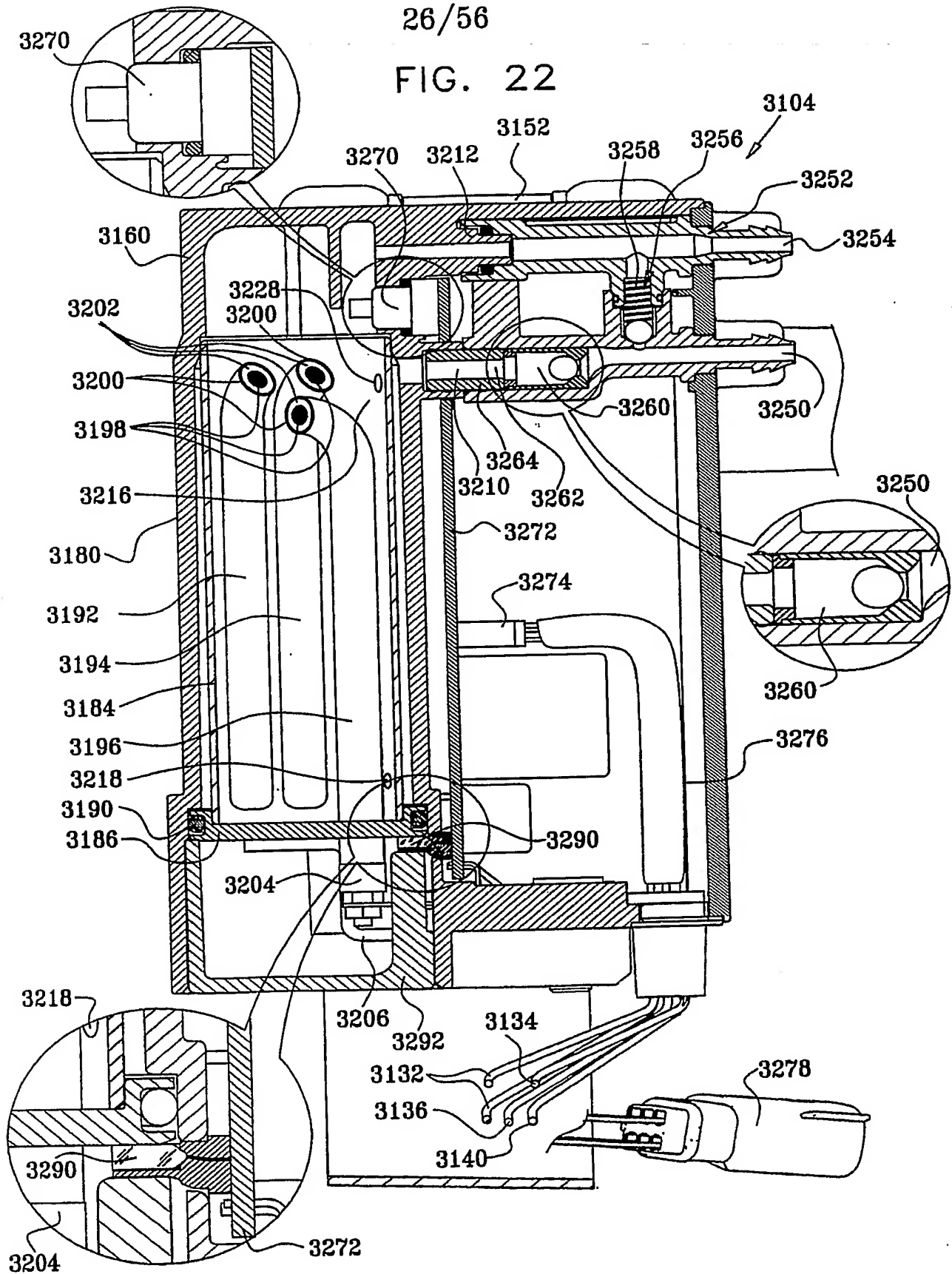
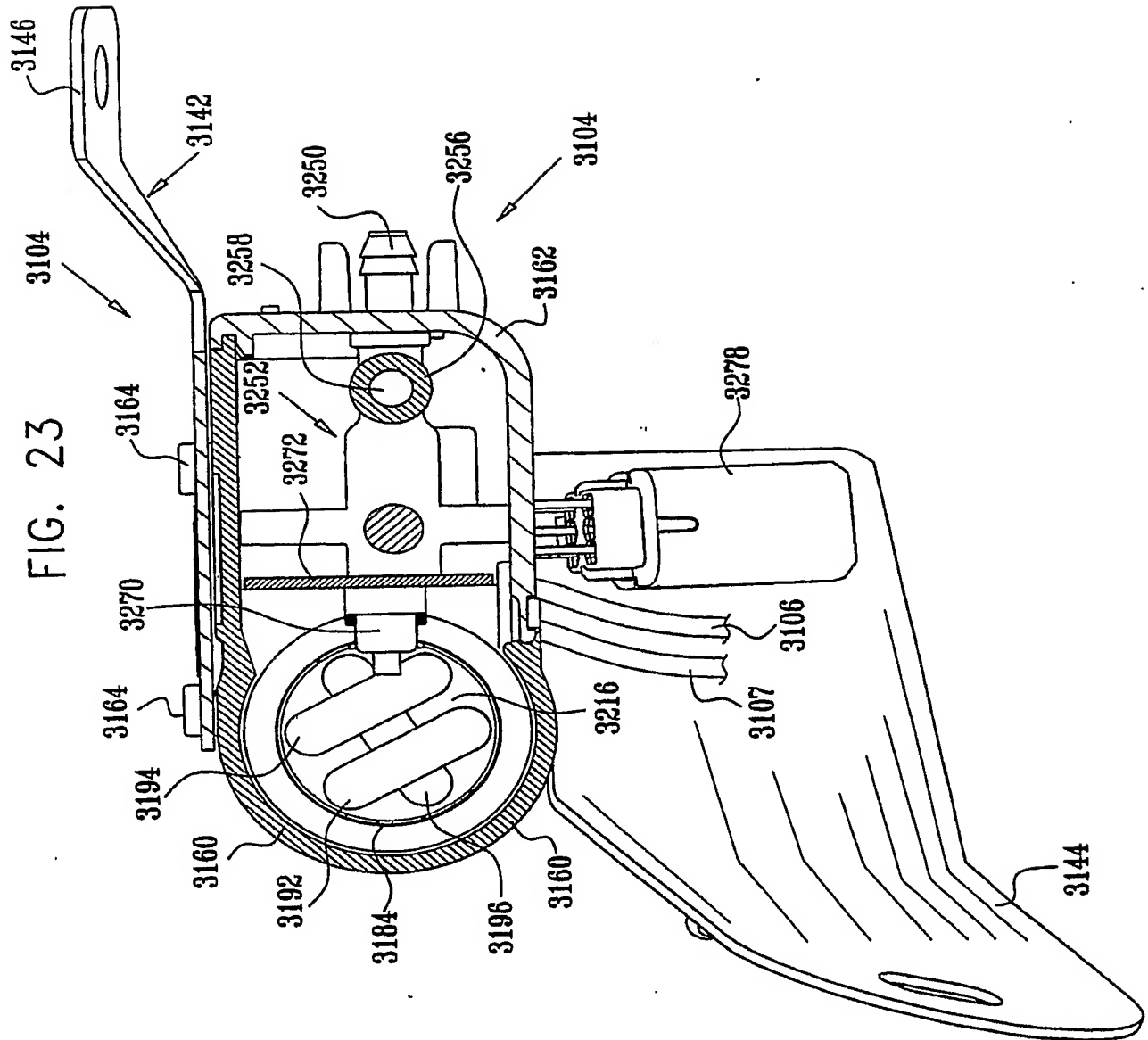
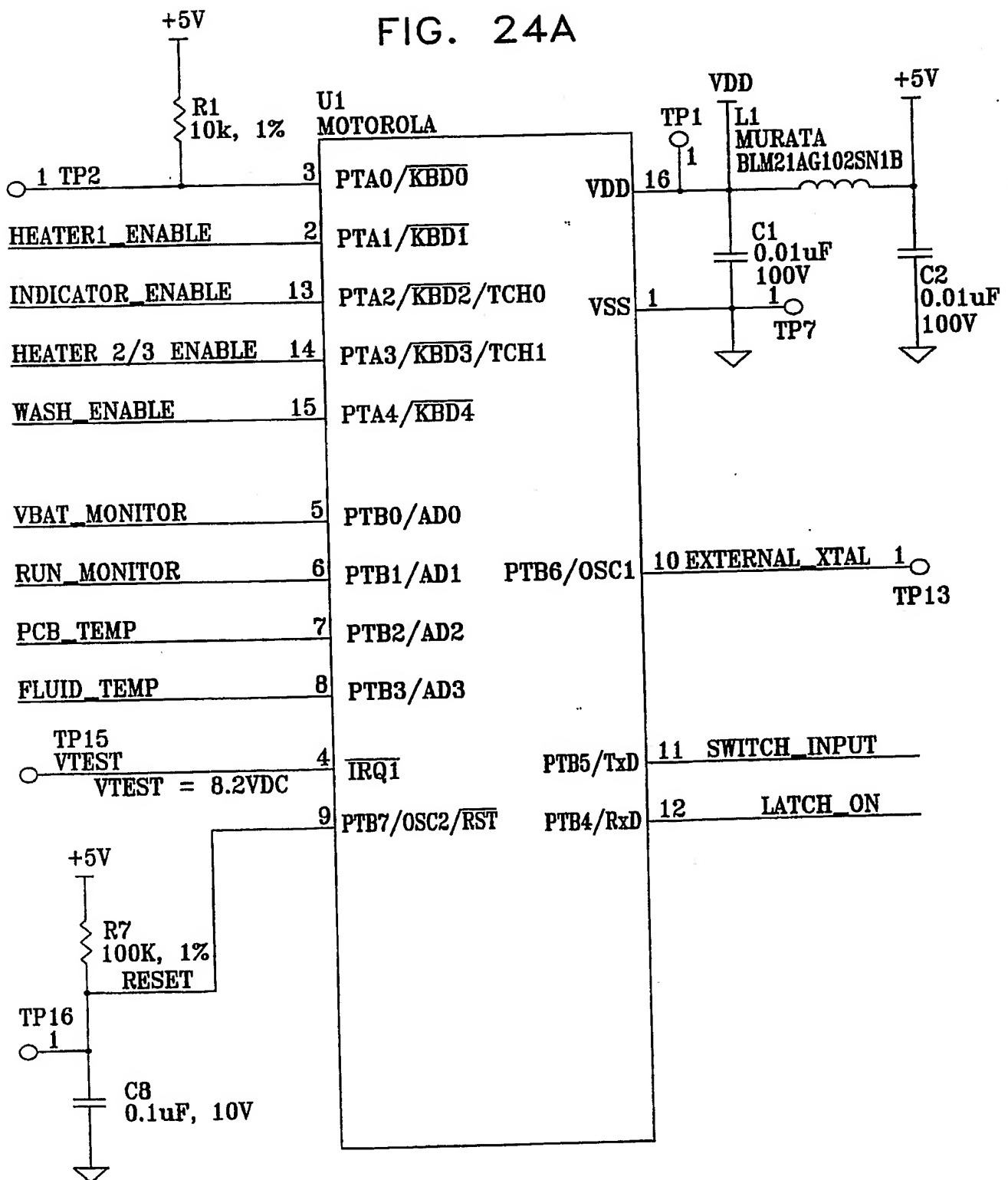


FIG. 23



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FIG. 24A



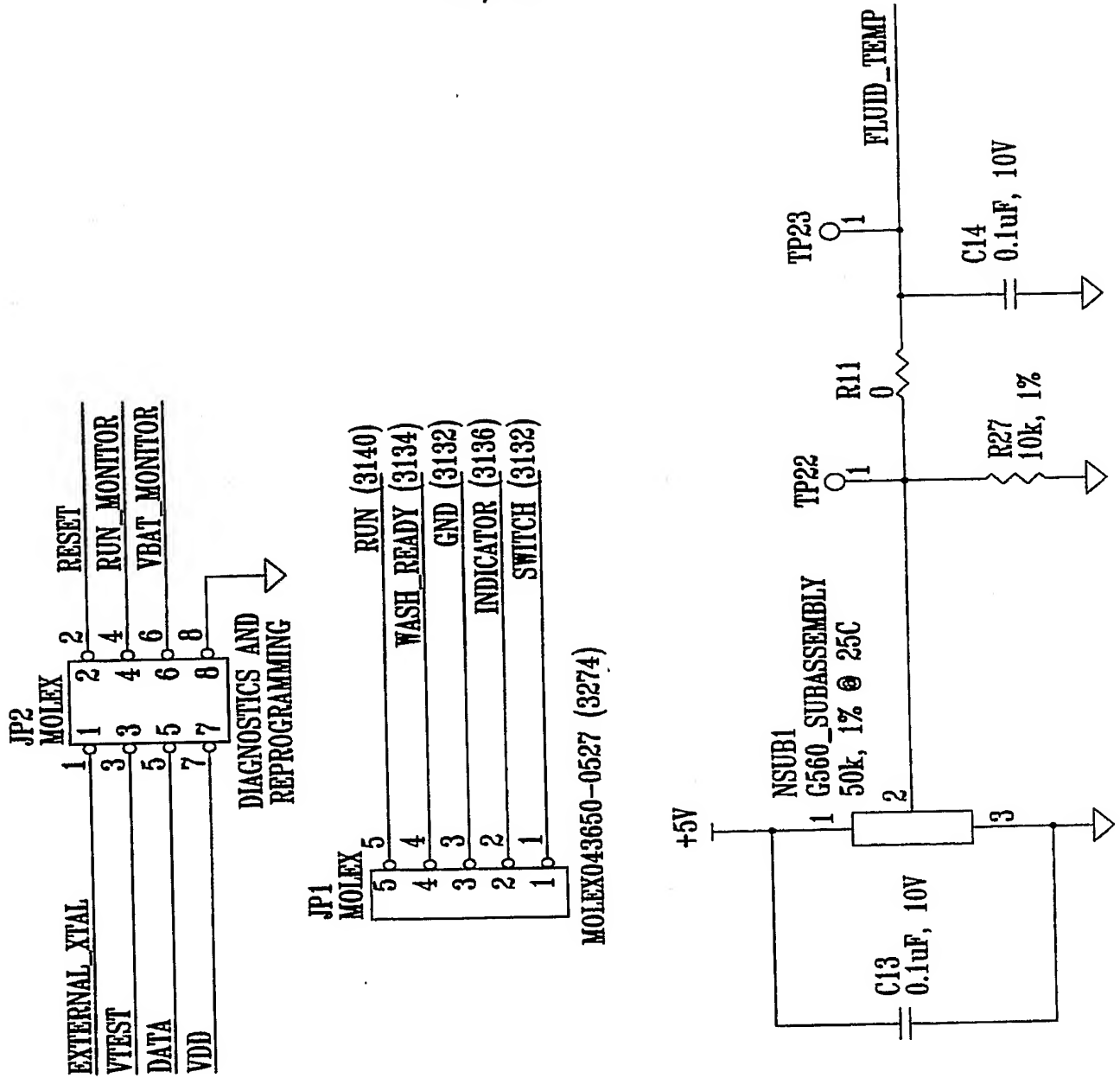


FIG. 24B



FIG. 24C/2

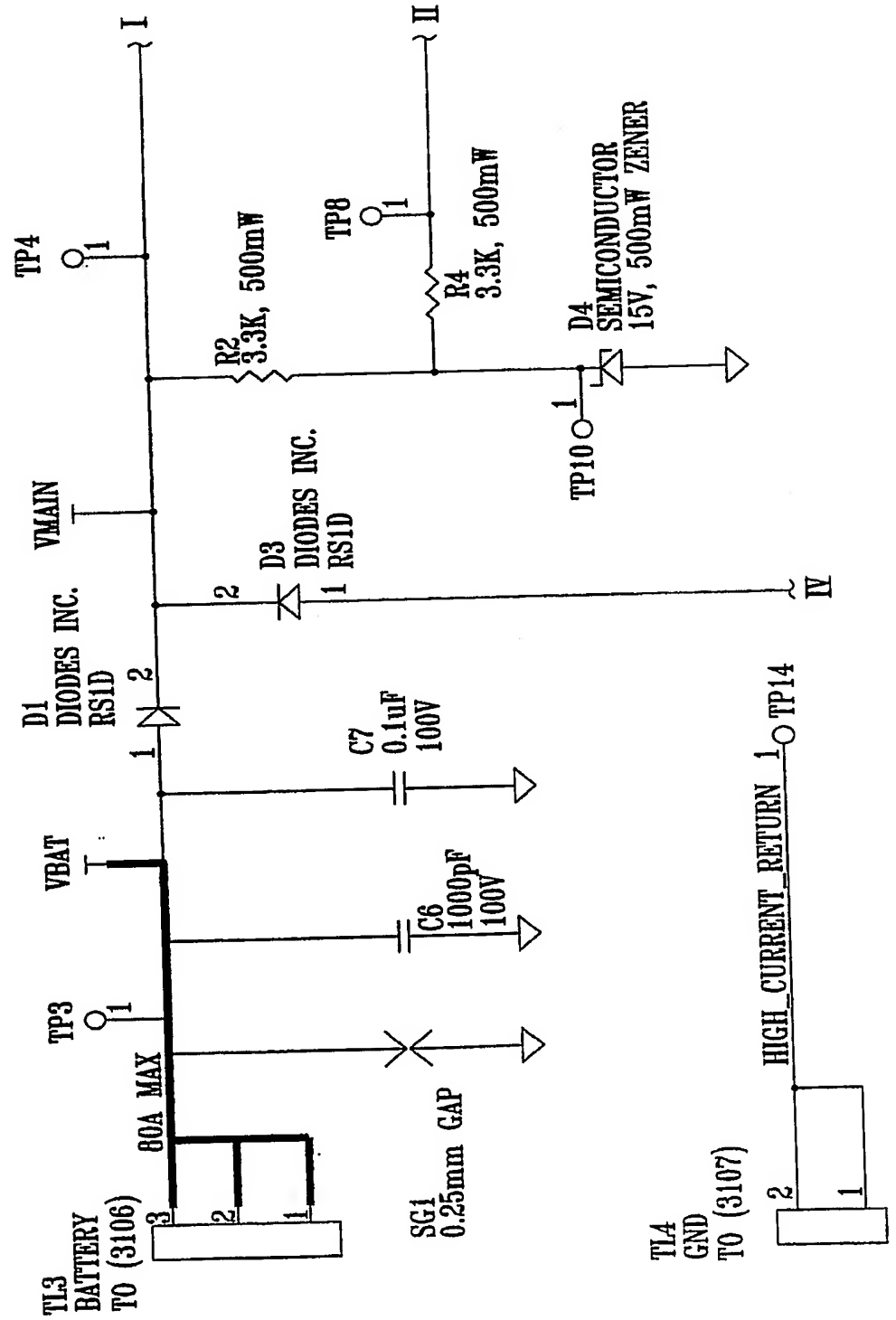


FIG. 24C/3

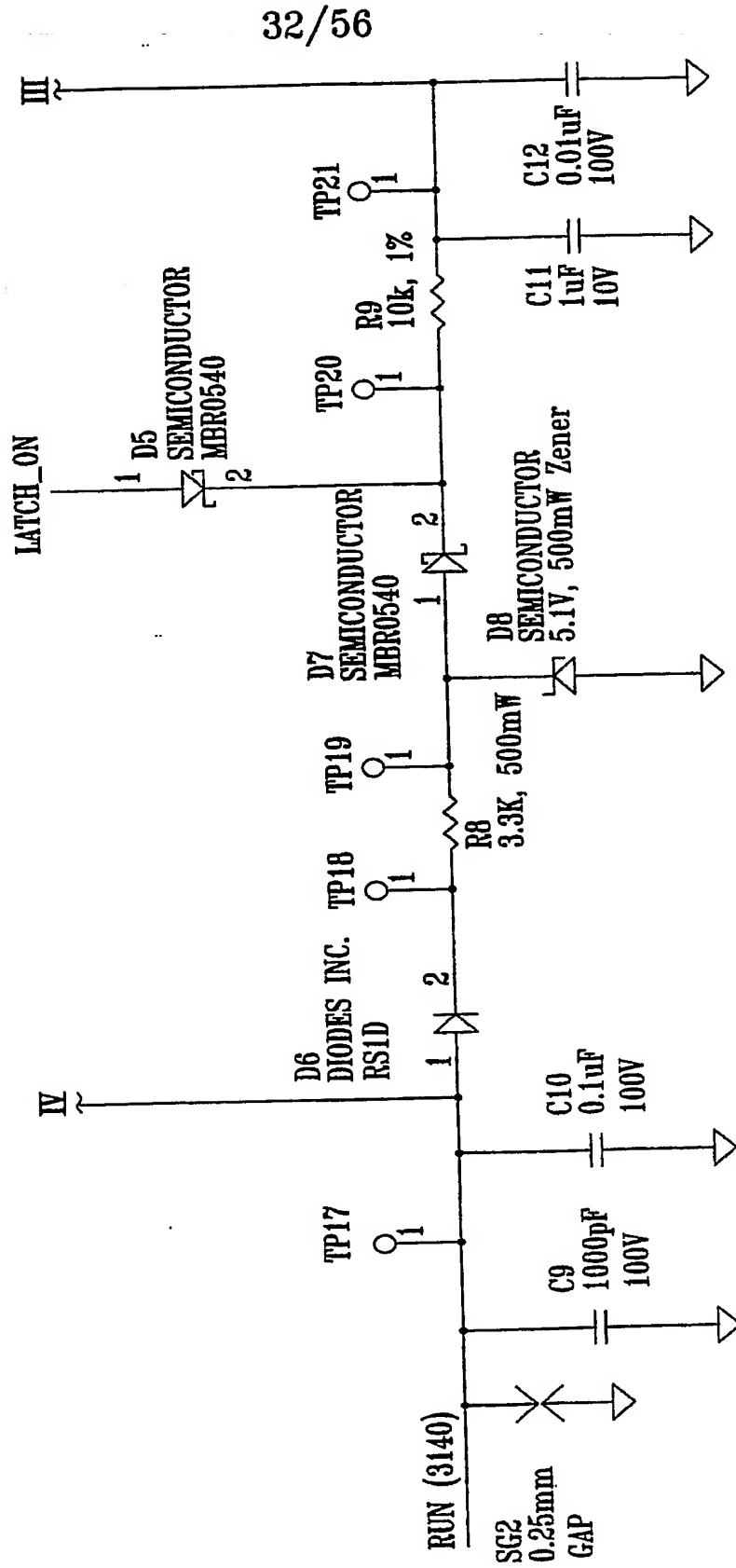


FIG. 24D

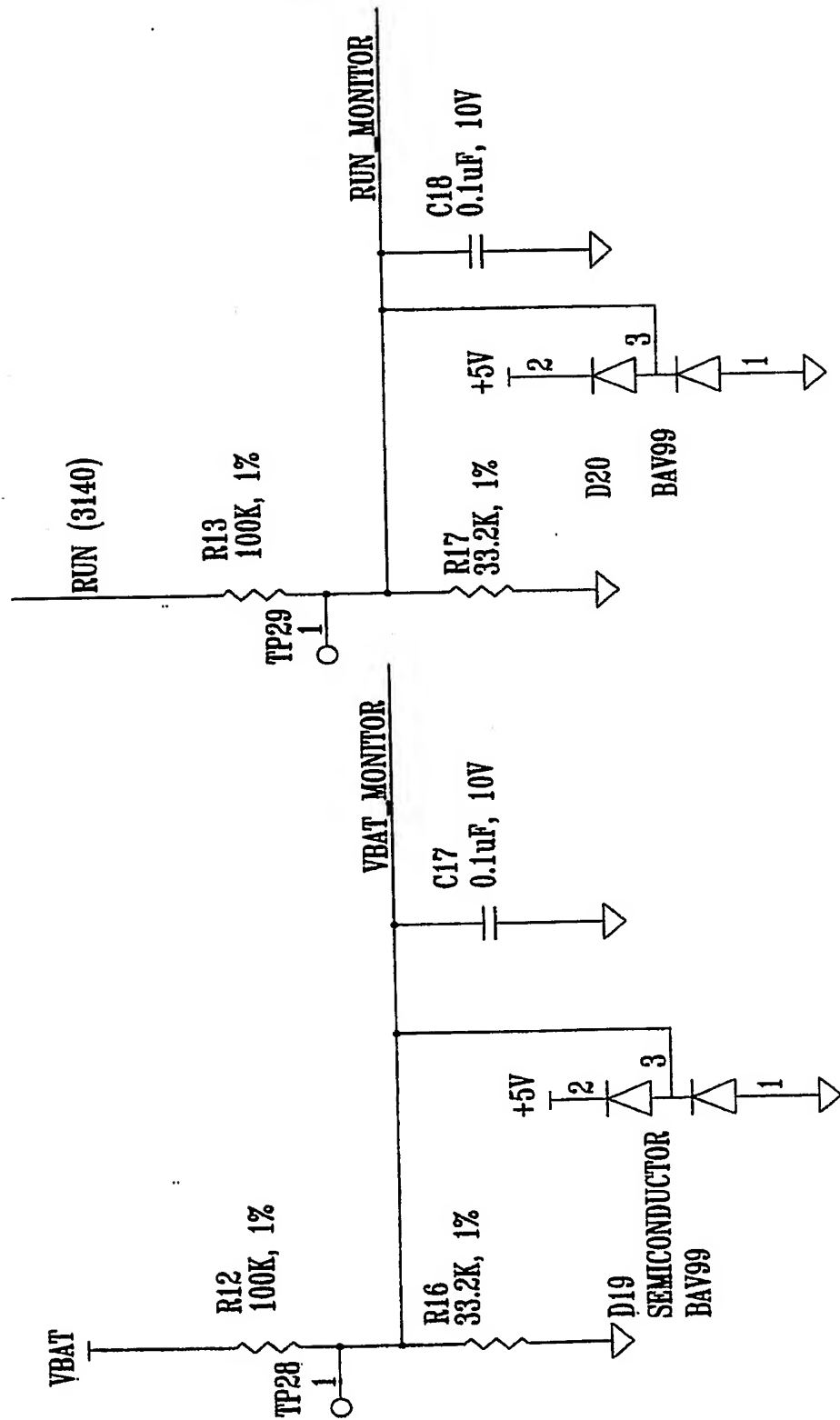
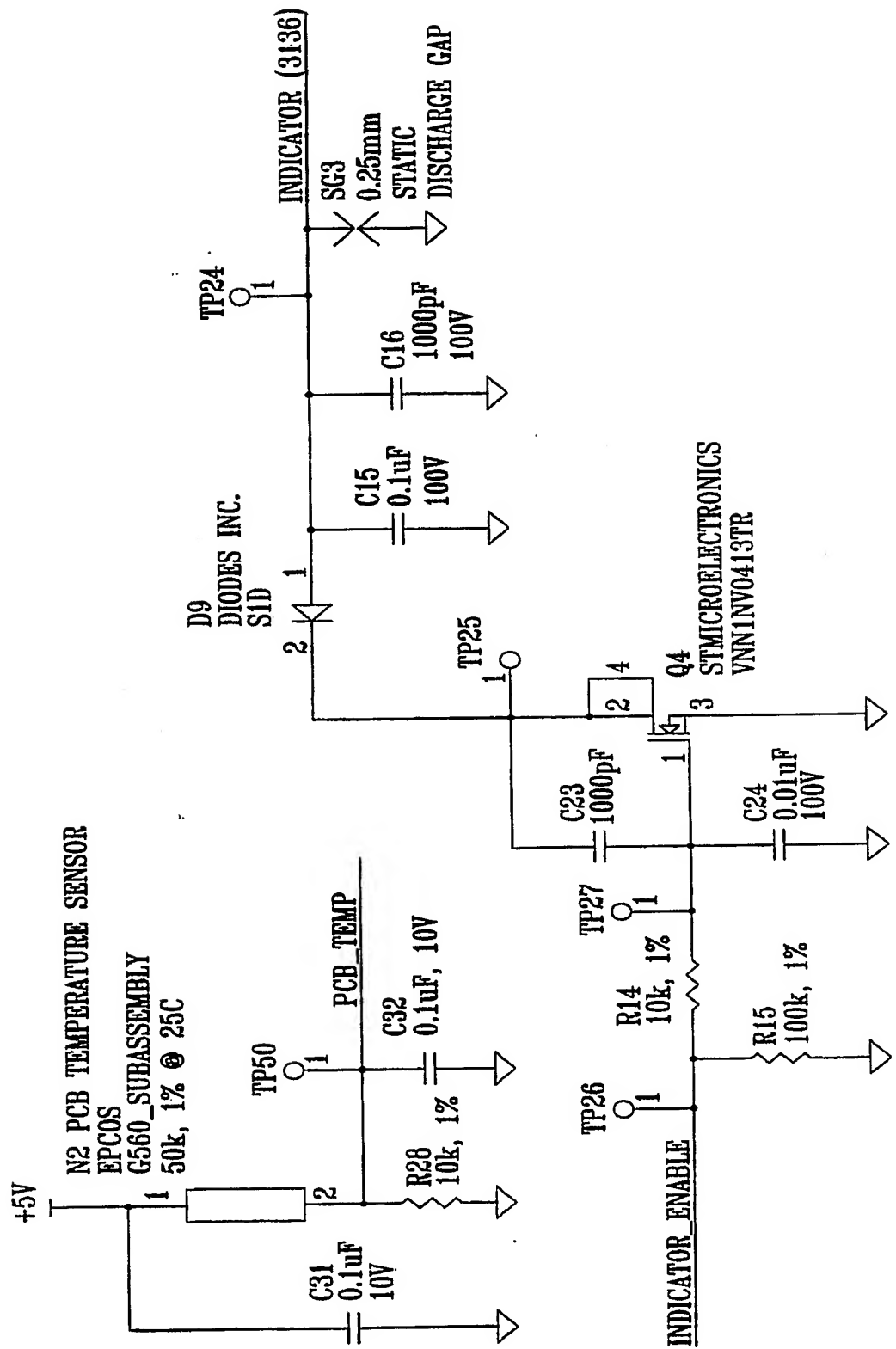
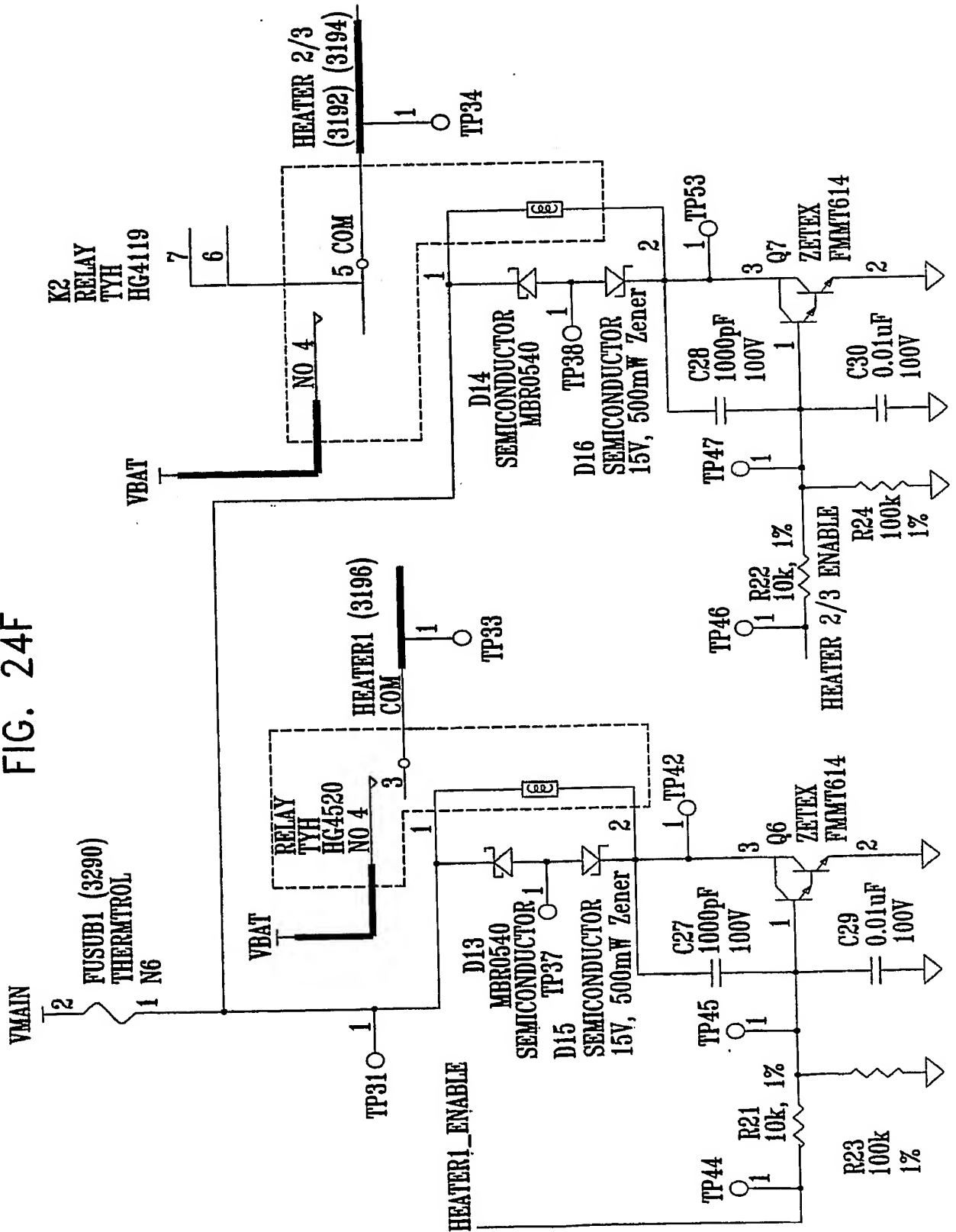


FIG. 24E



**FIG. 24F**



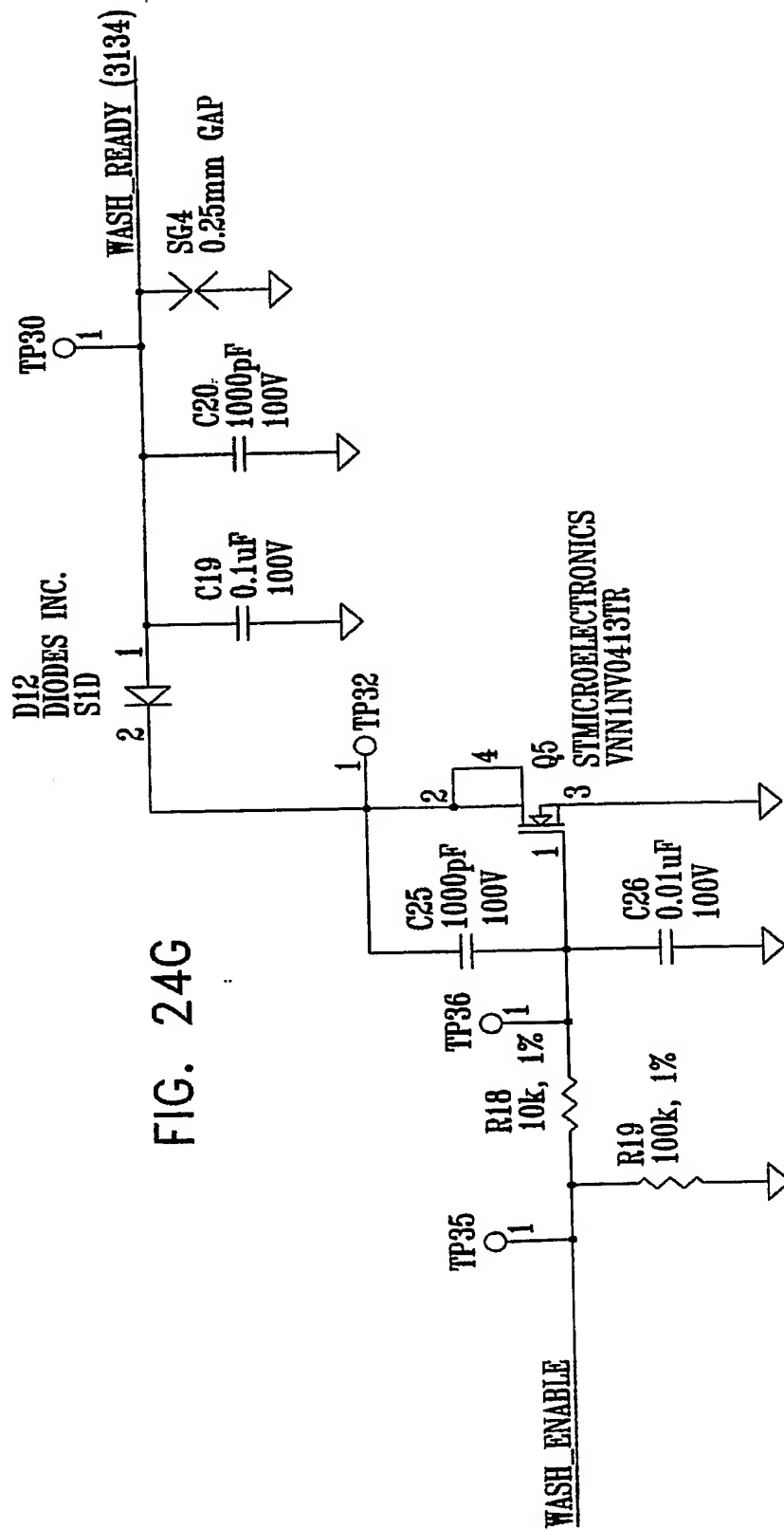
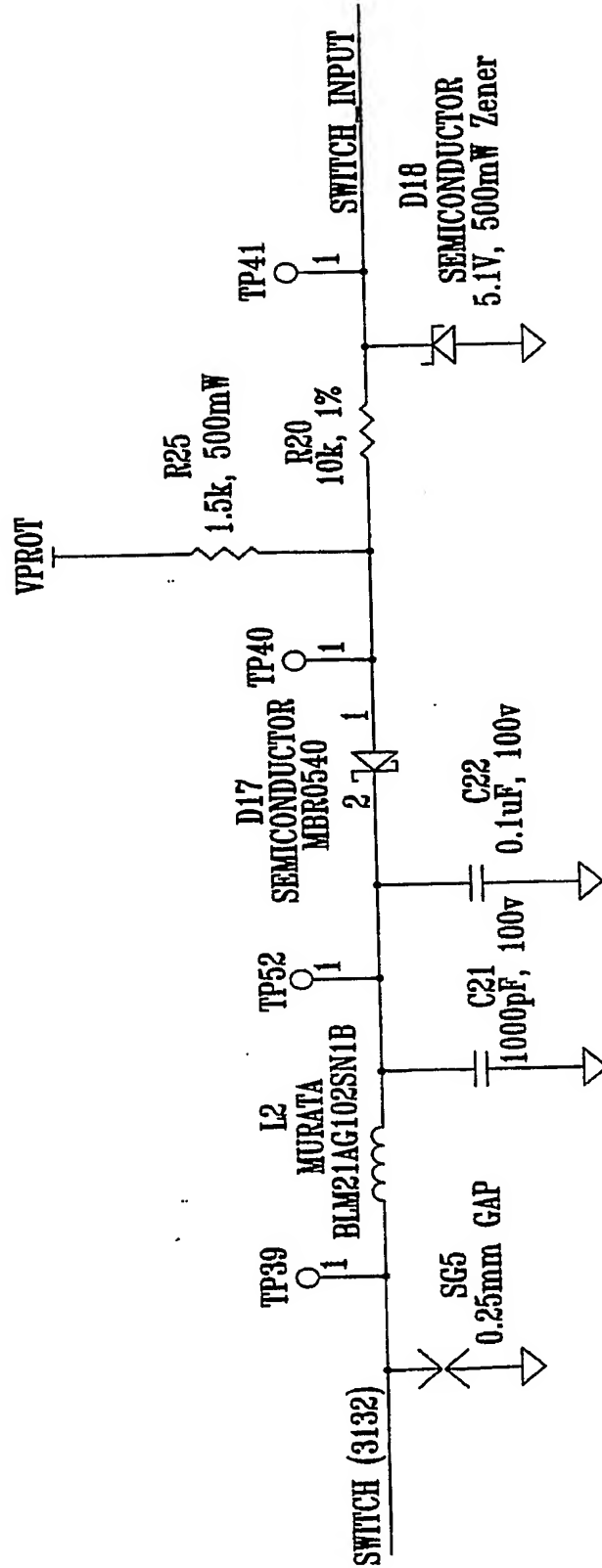


FIG. 24H



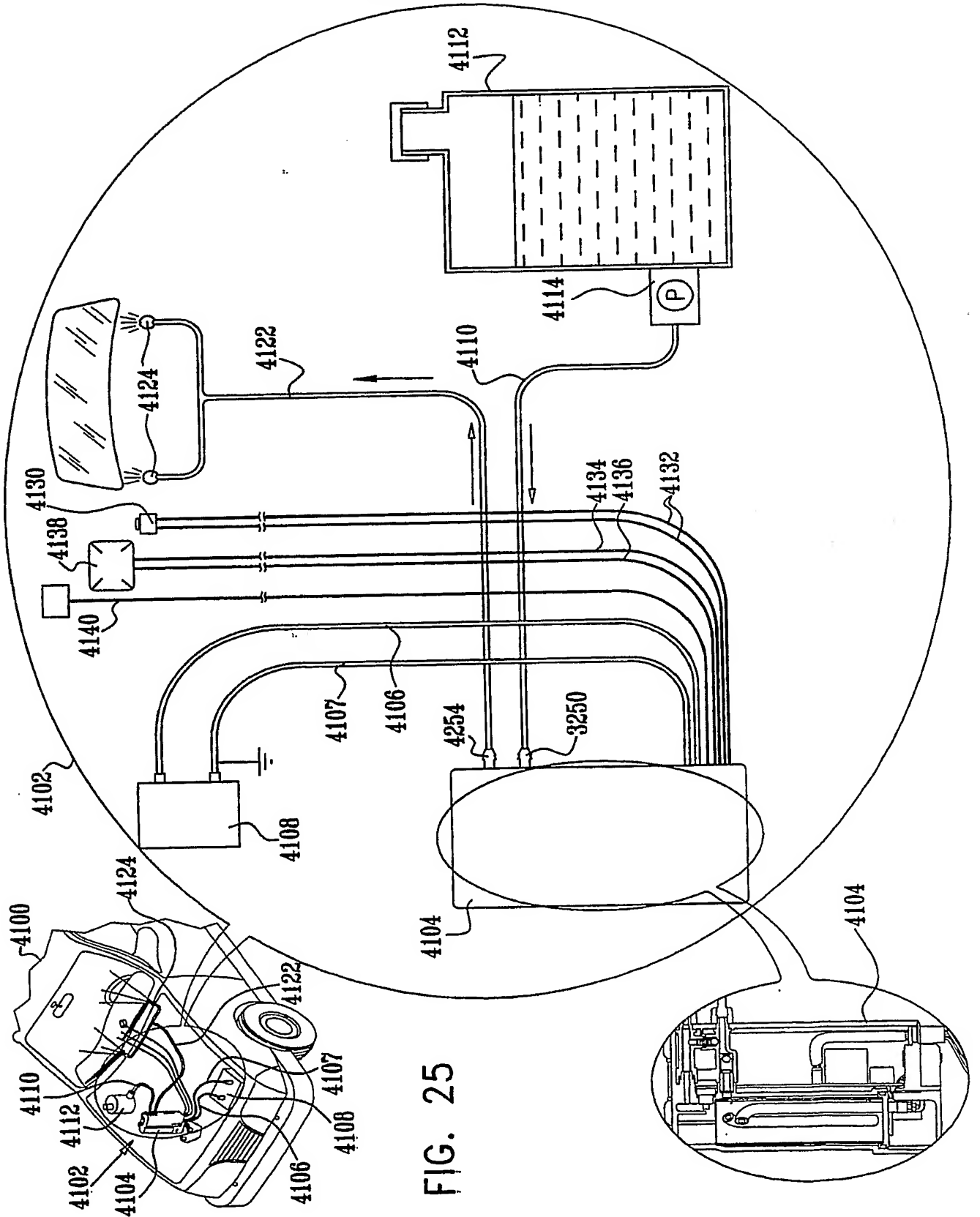


FIG. 25

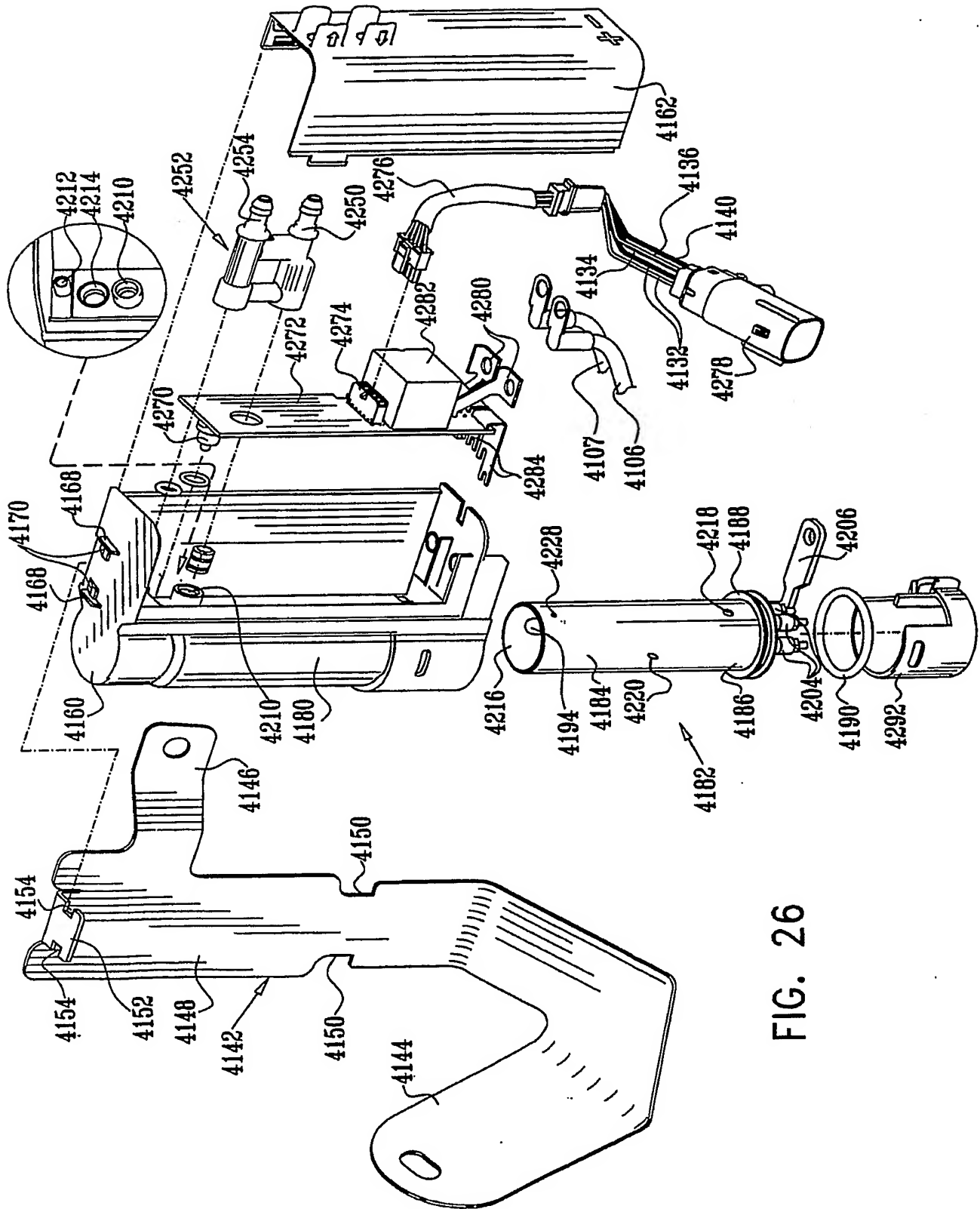
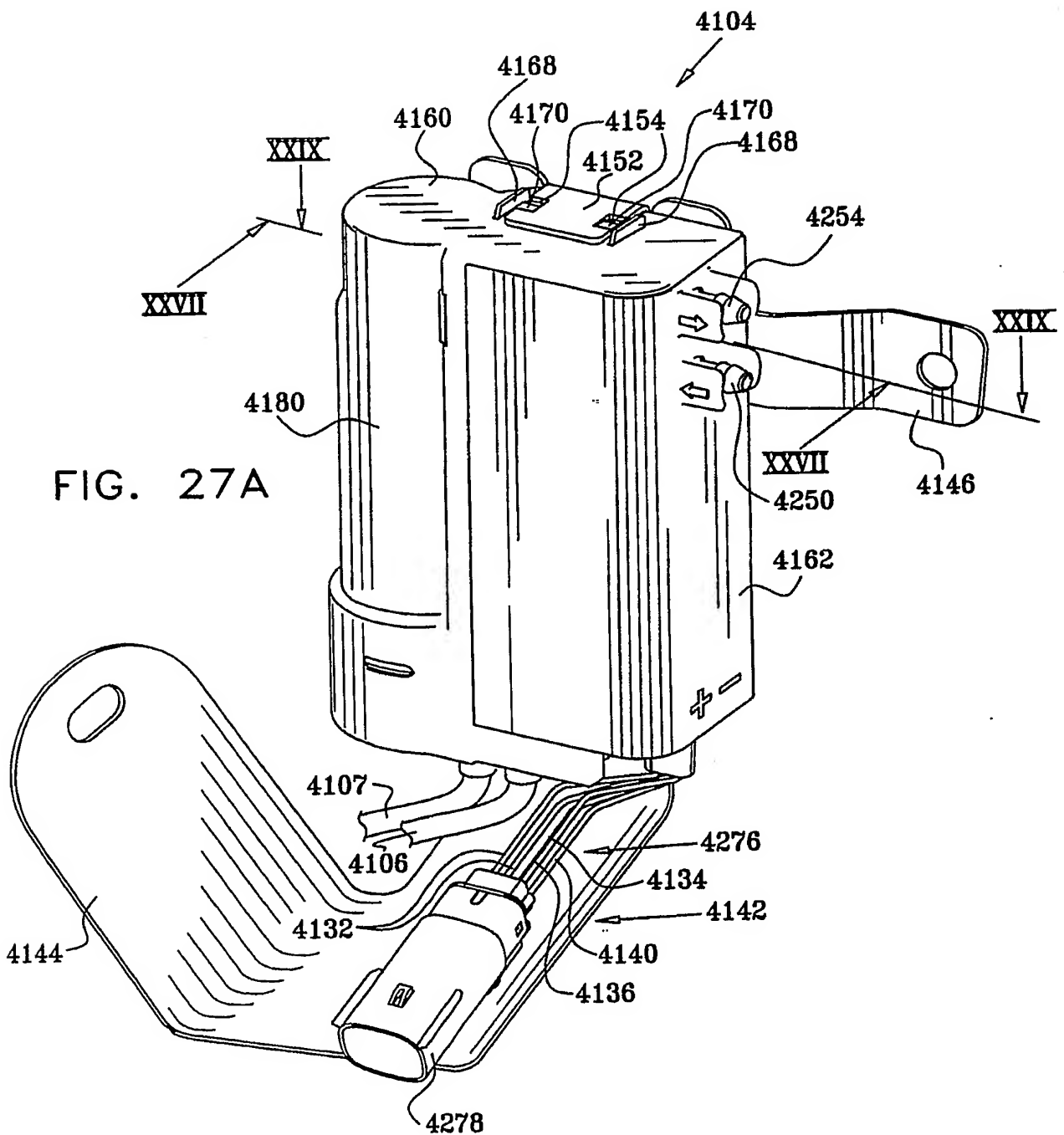
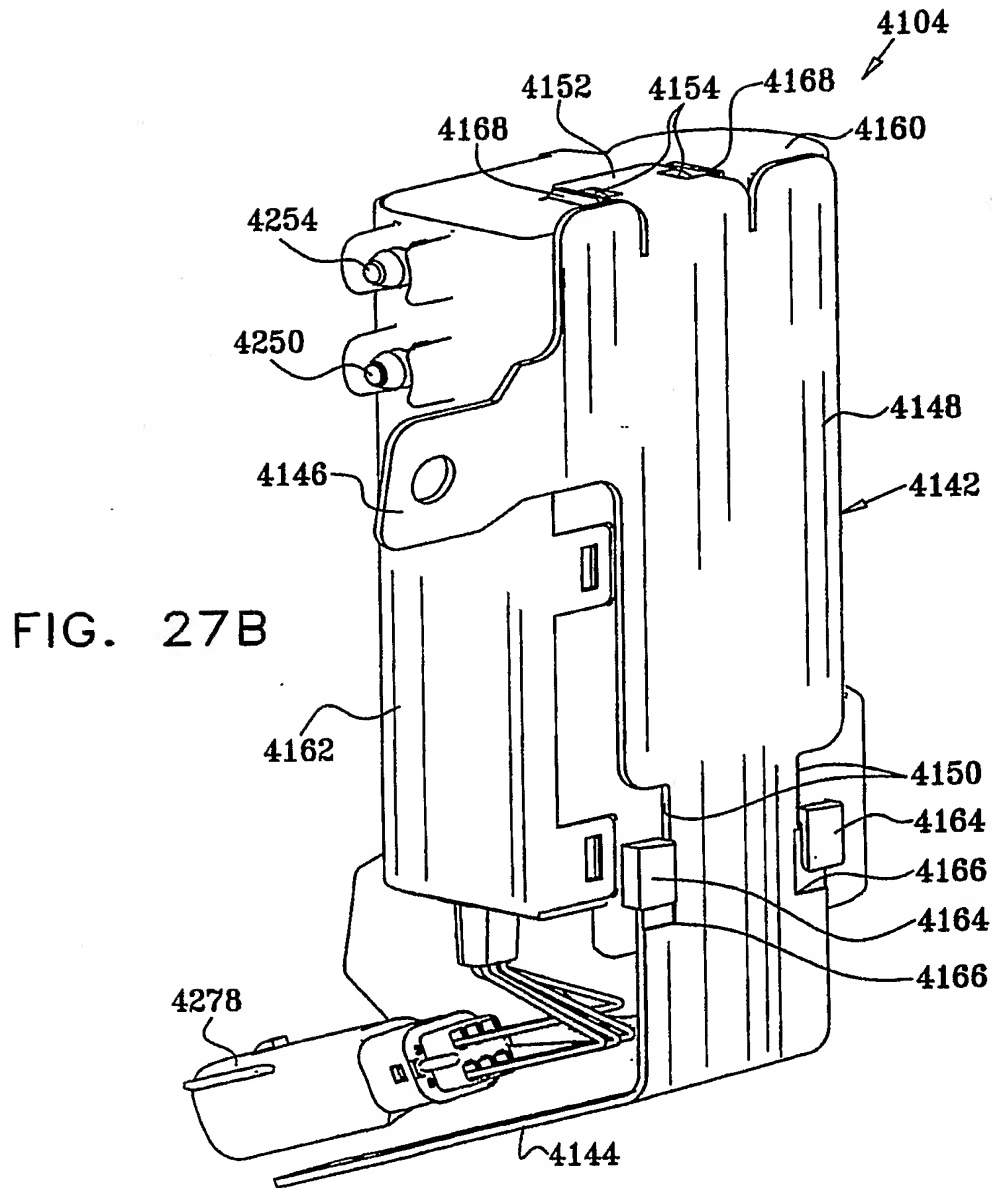


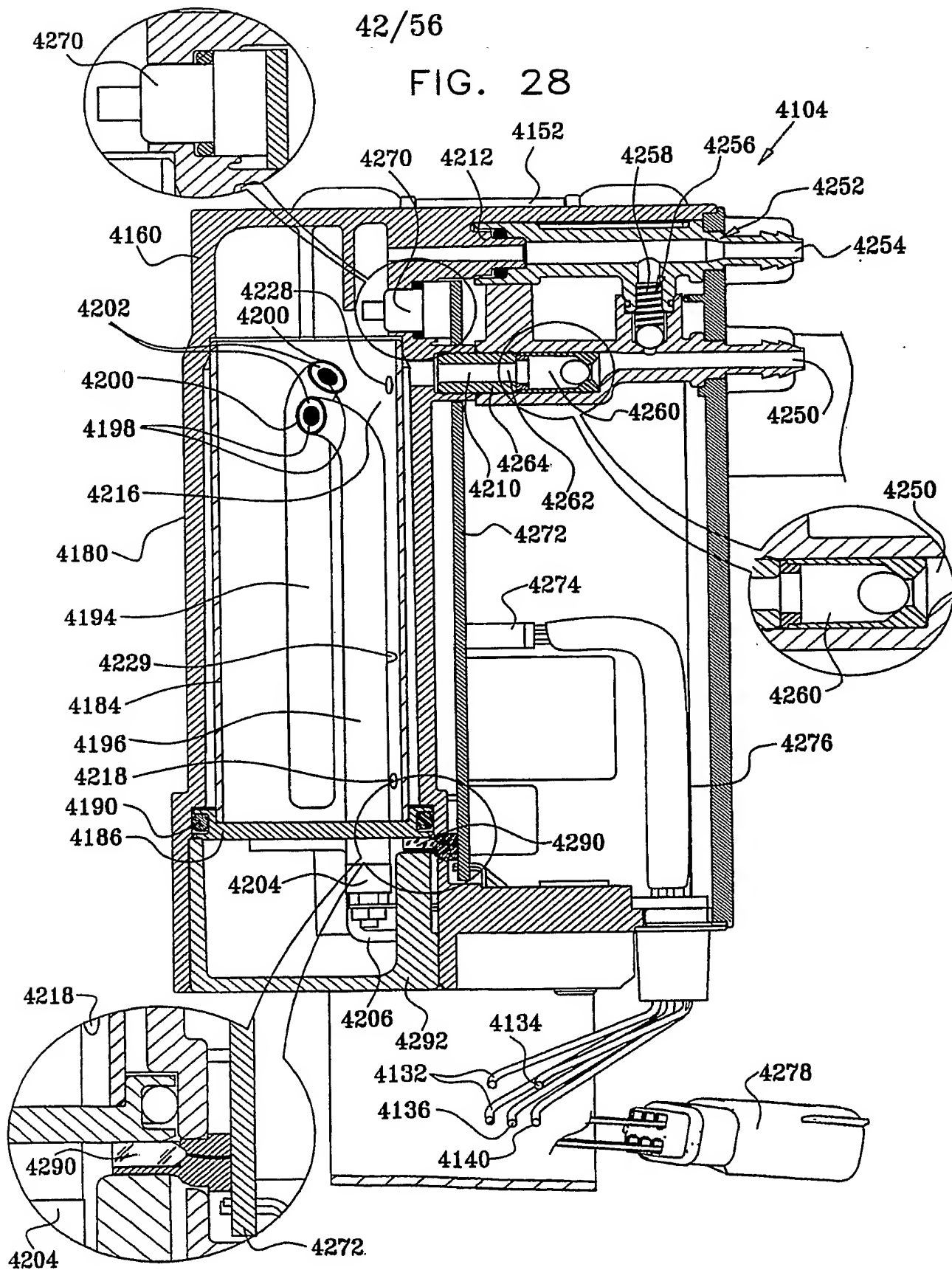
FIG. 26





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FIG. 28



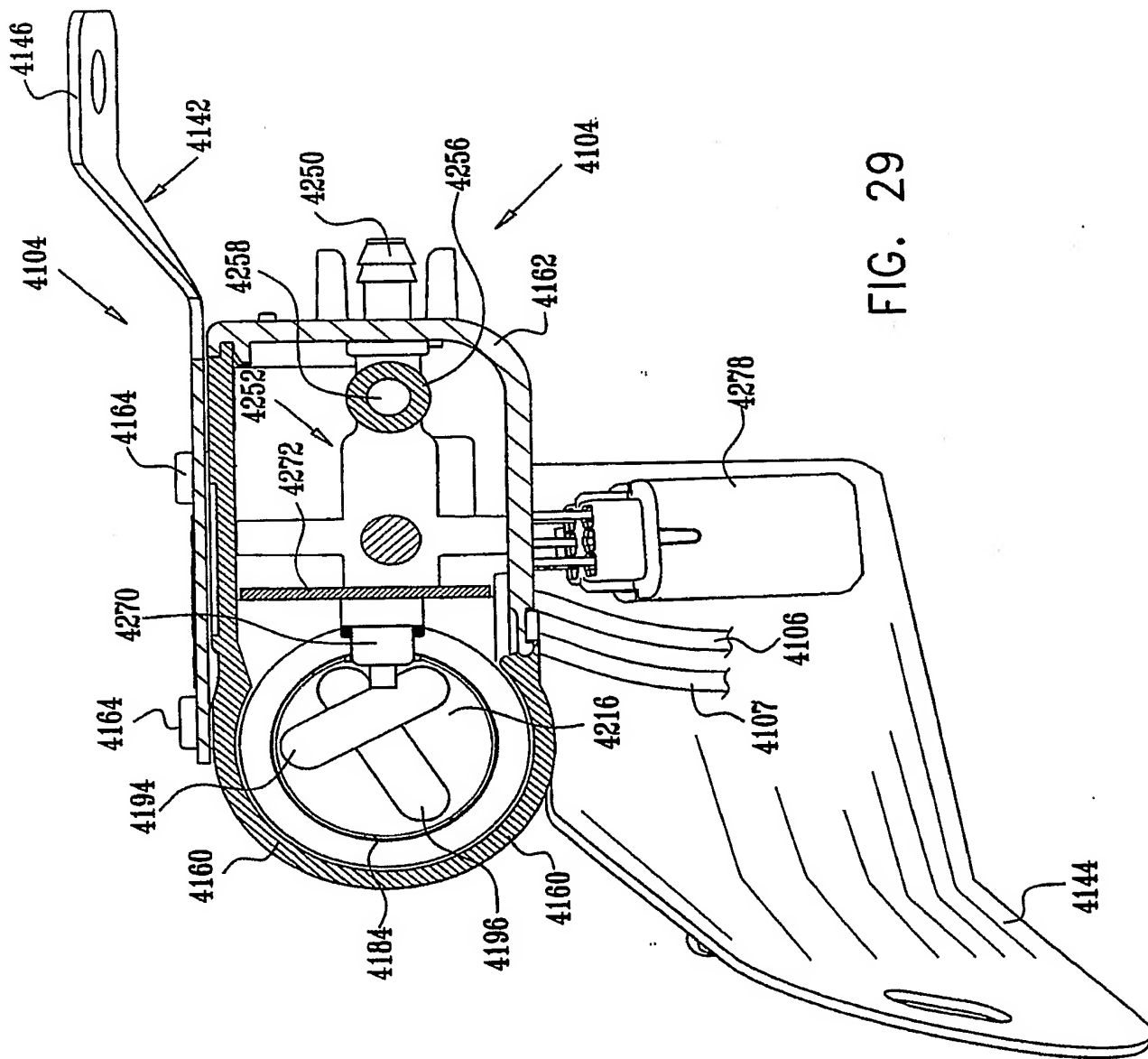
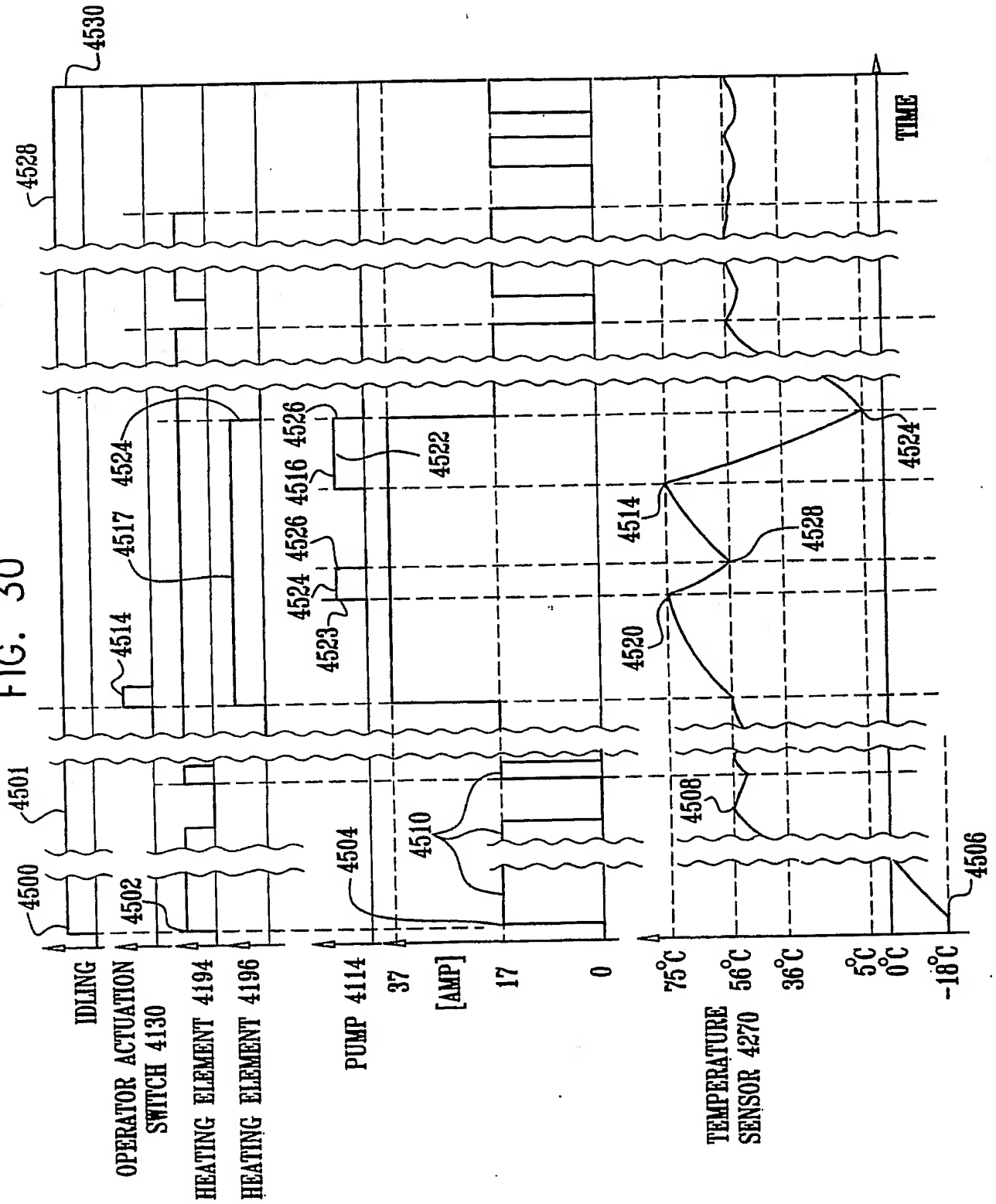


FIG. 29

FIG. 30



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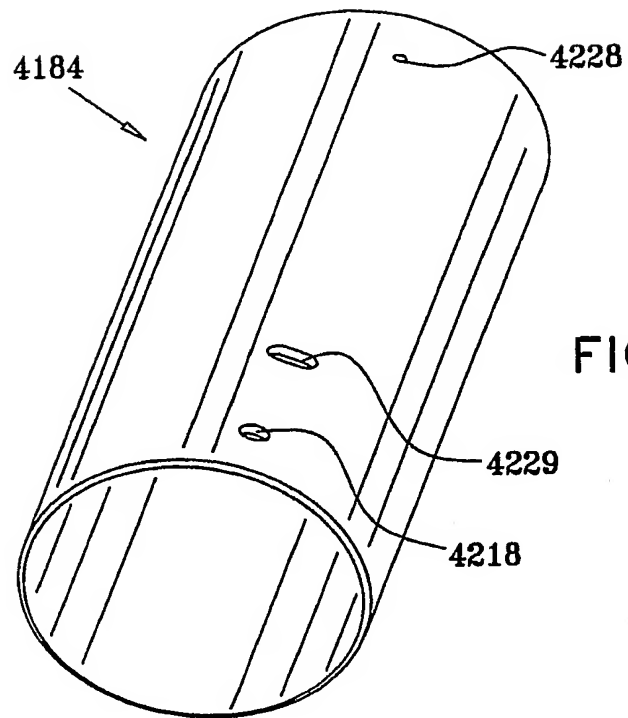


FIG. 31A

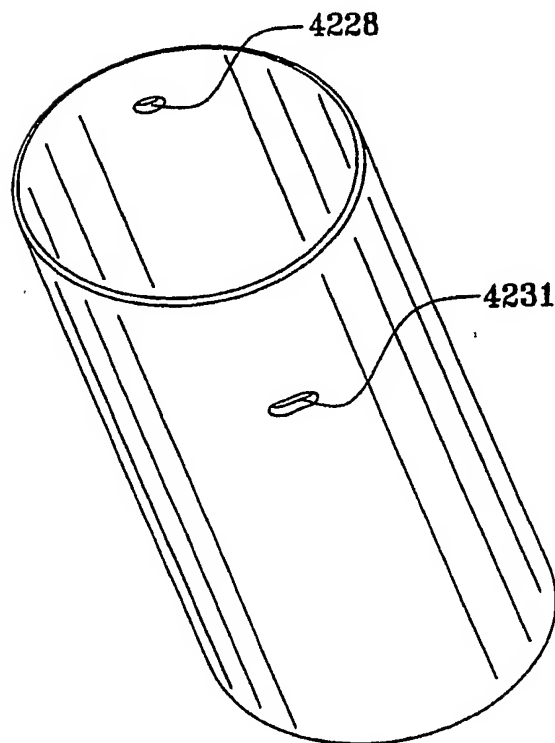


FIG. 31B

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FIG. 32

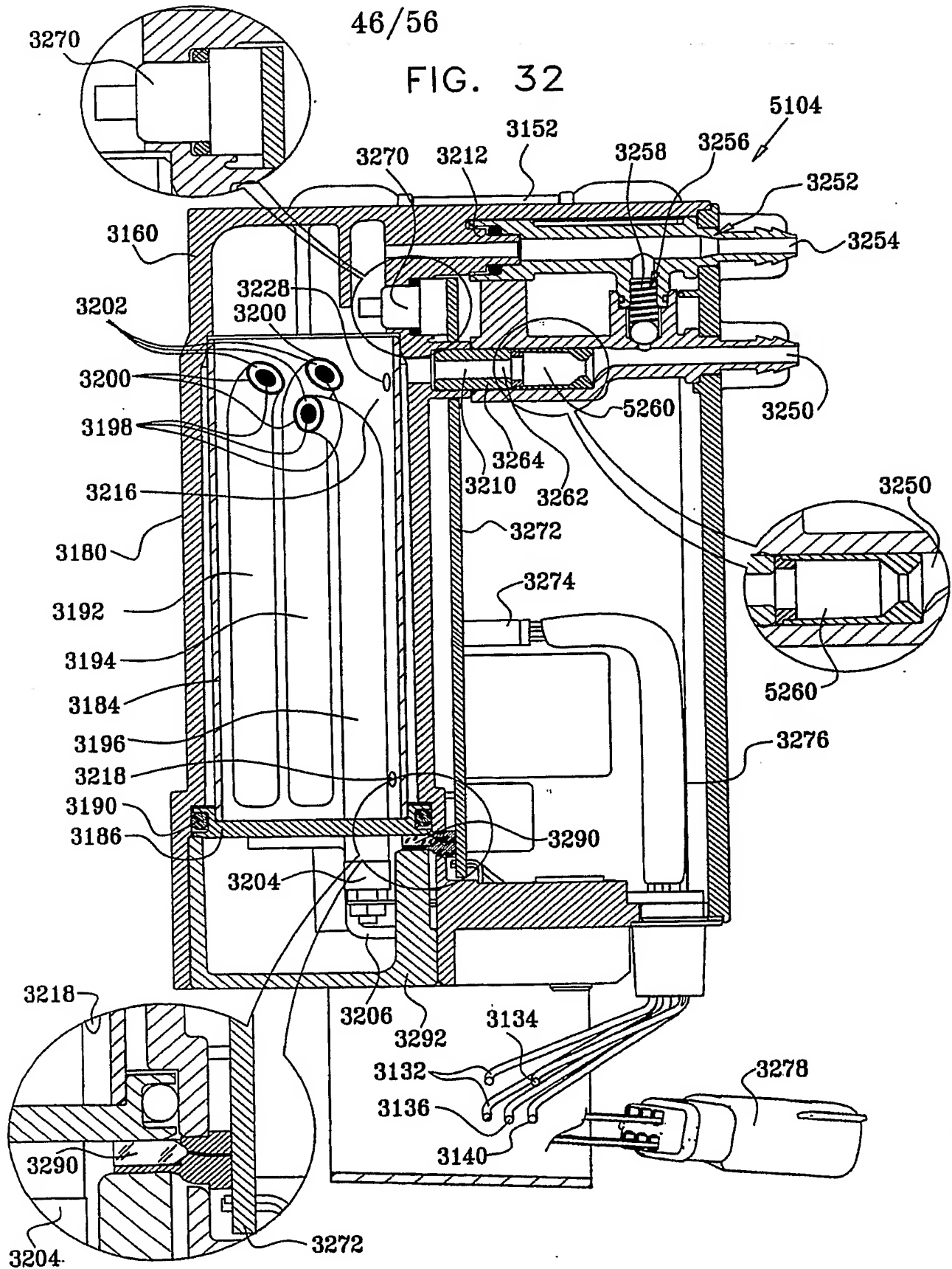


FIG. 33

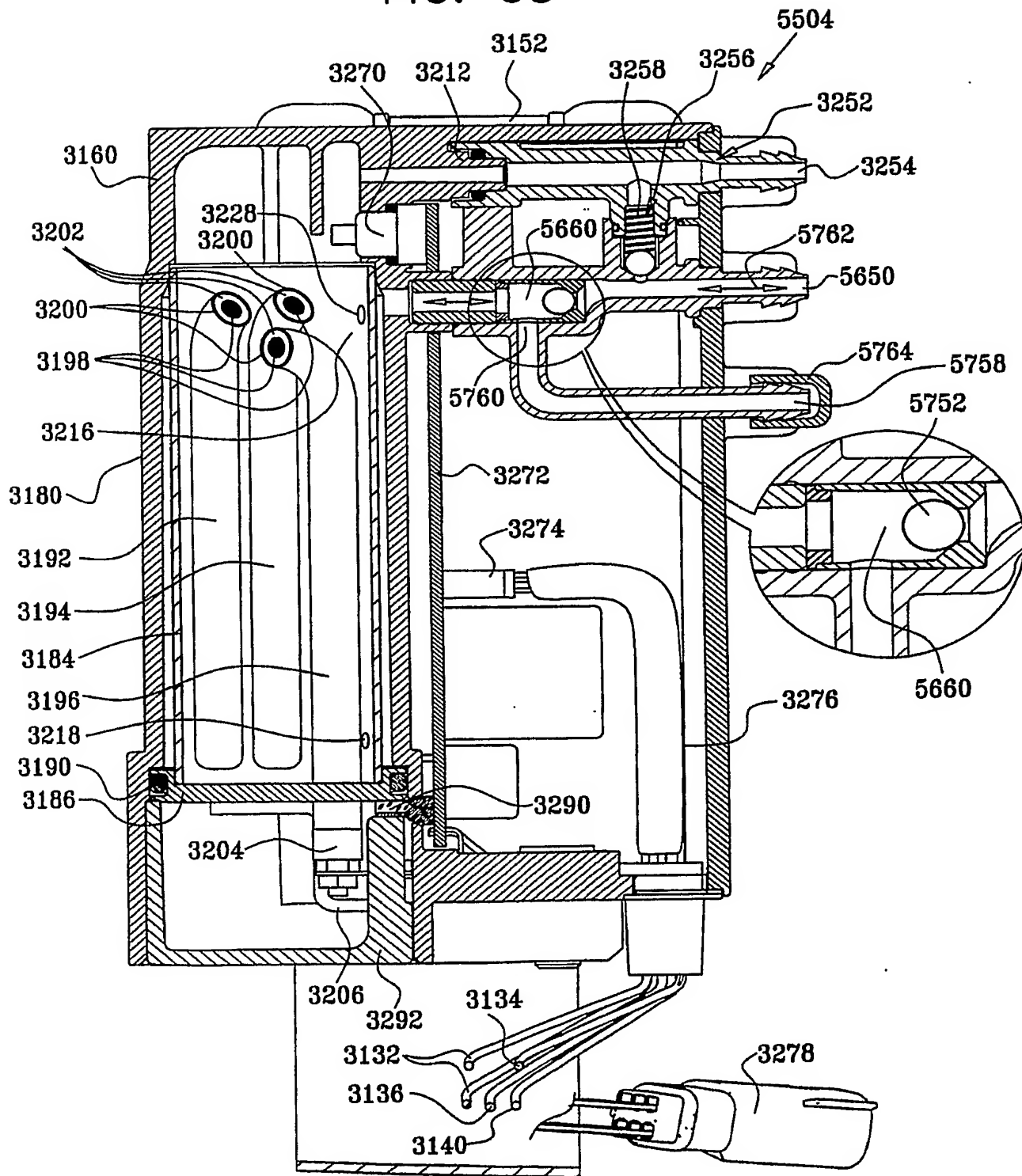


FIG. 34

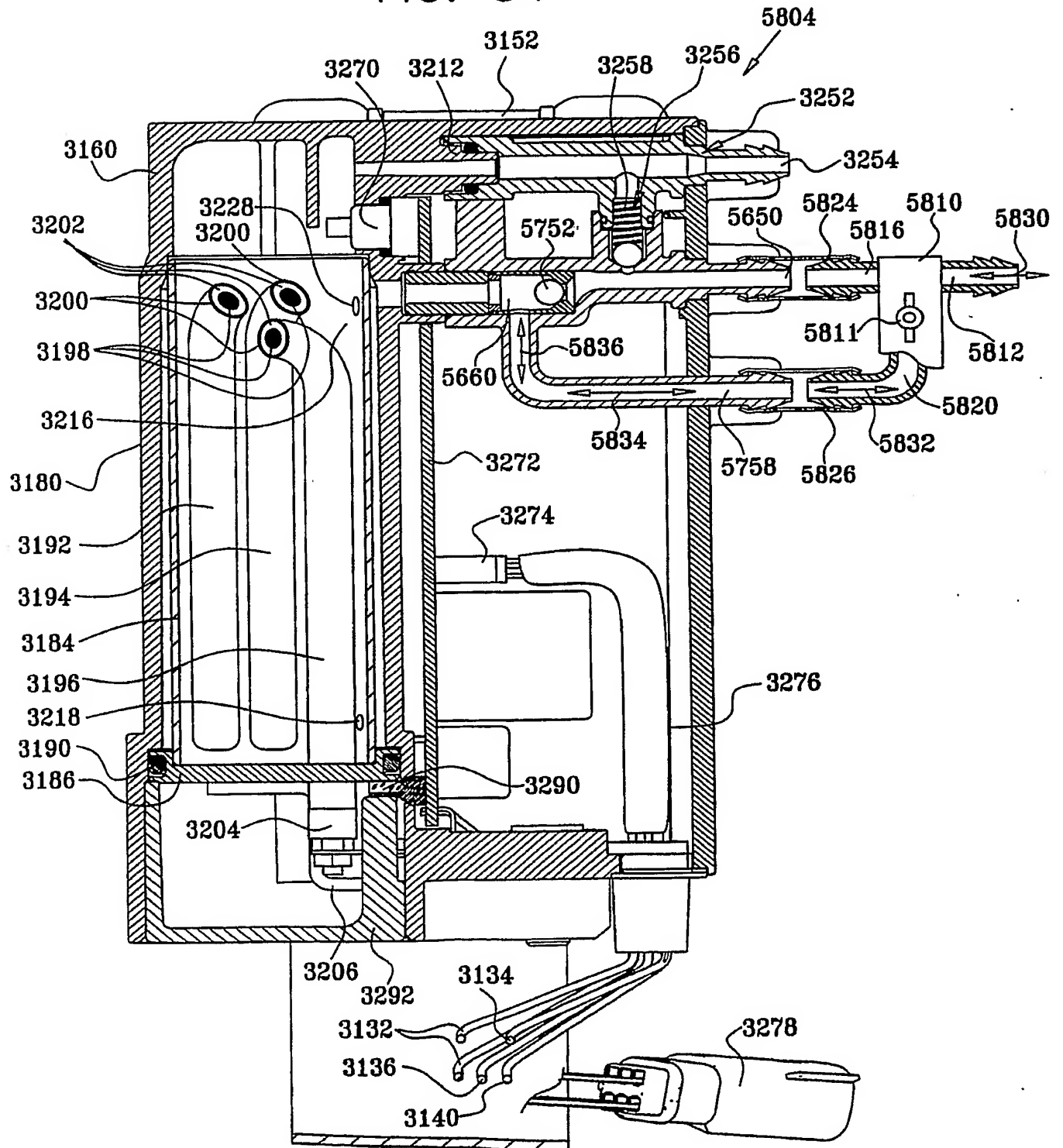
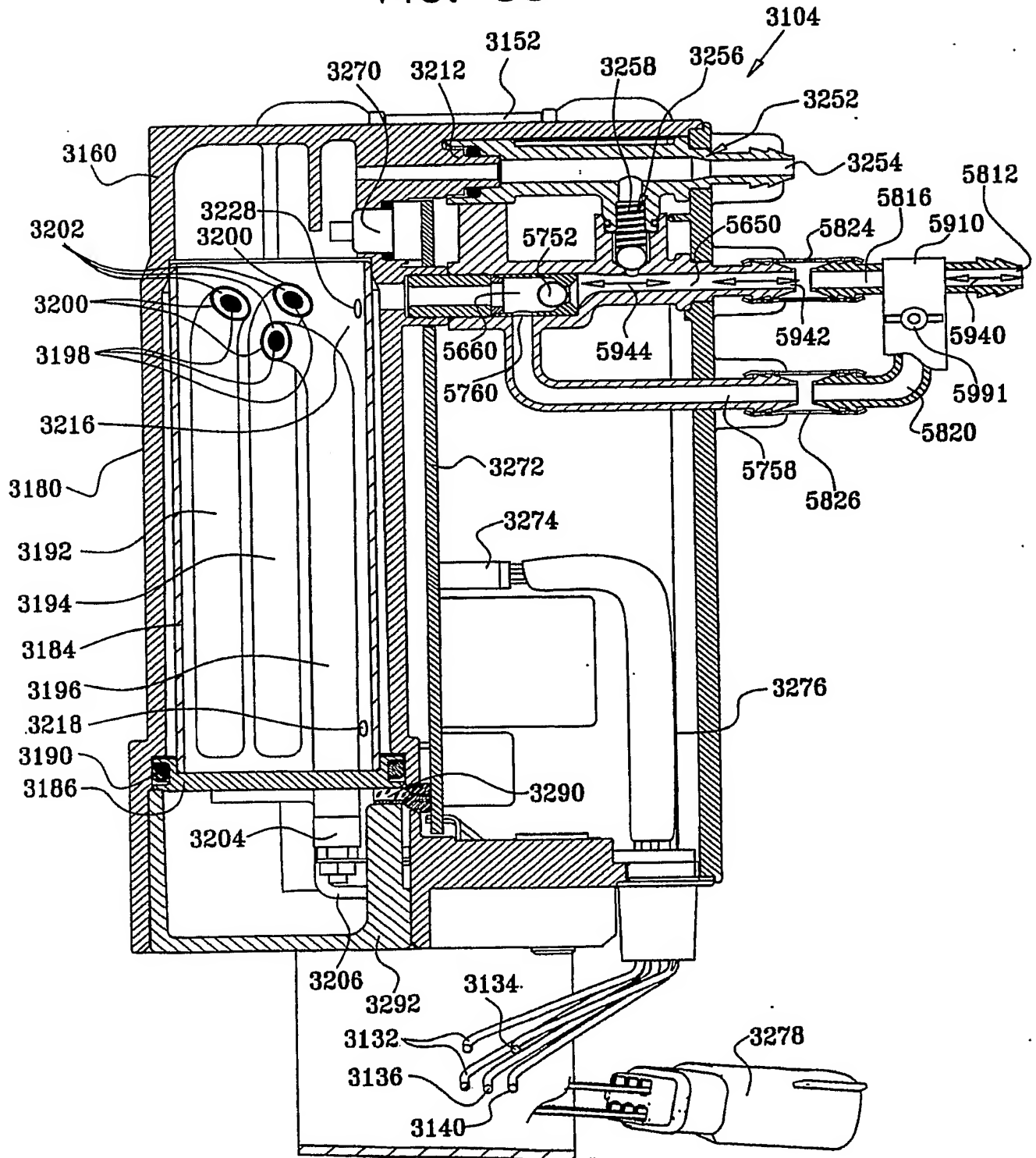
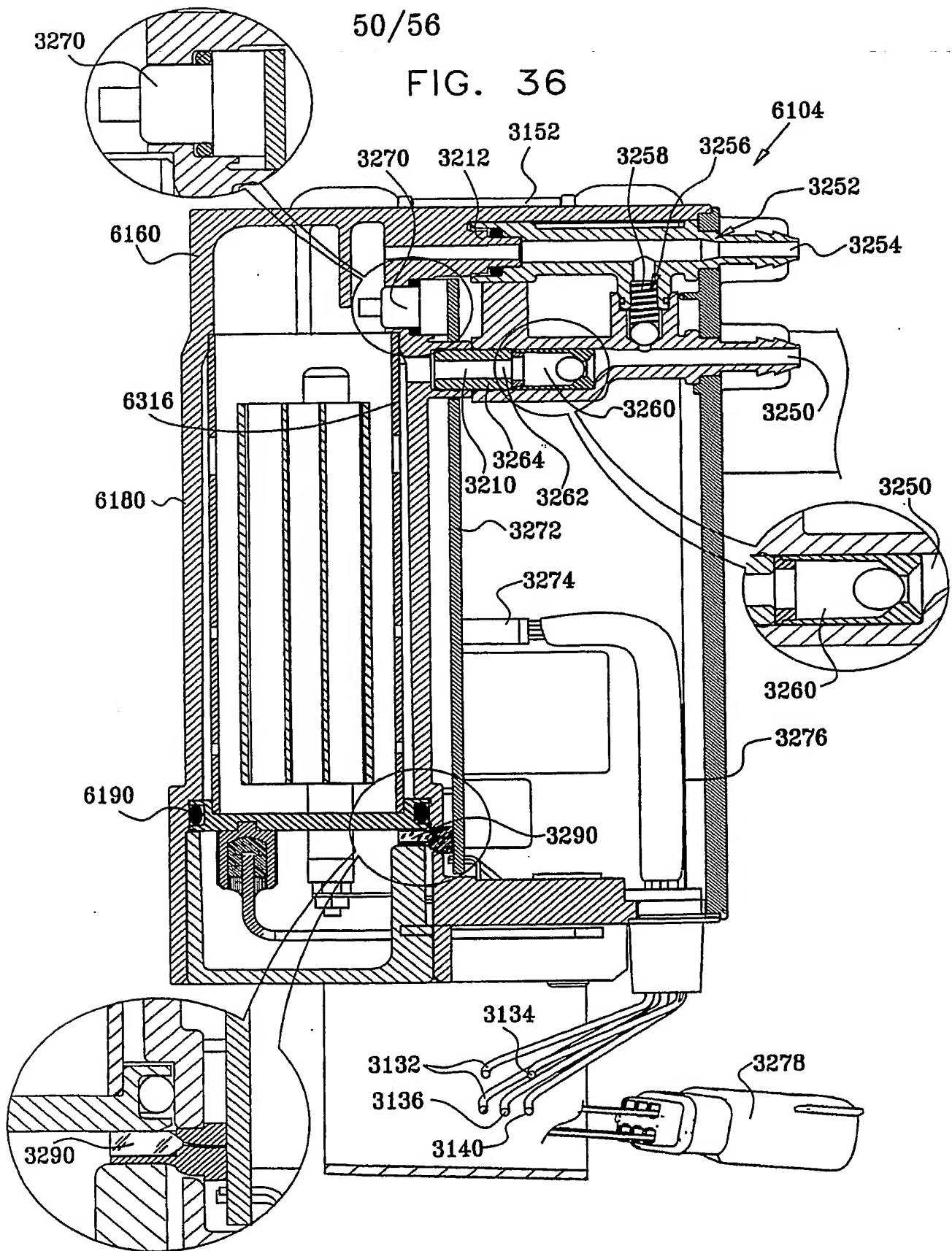


FIG. 35

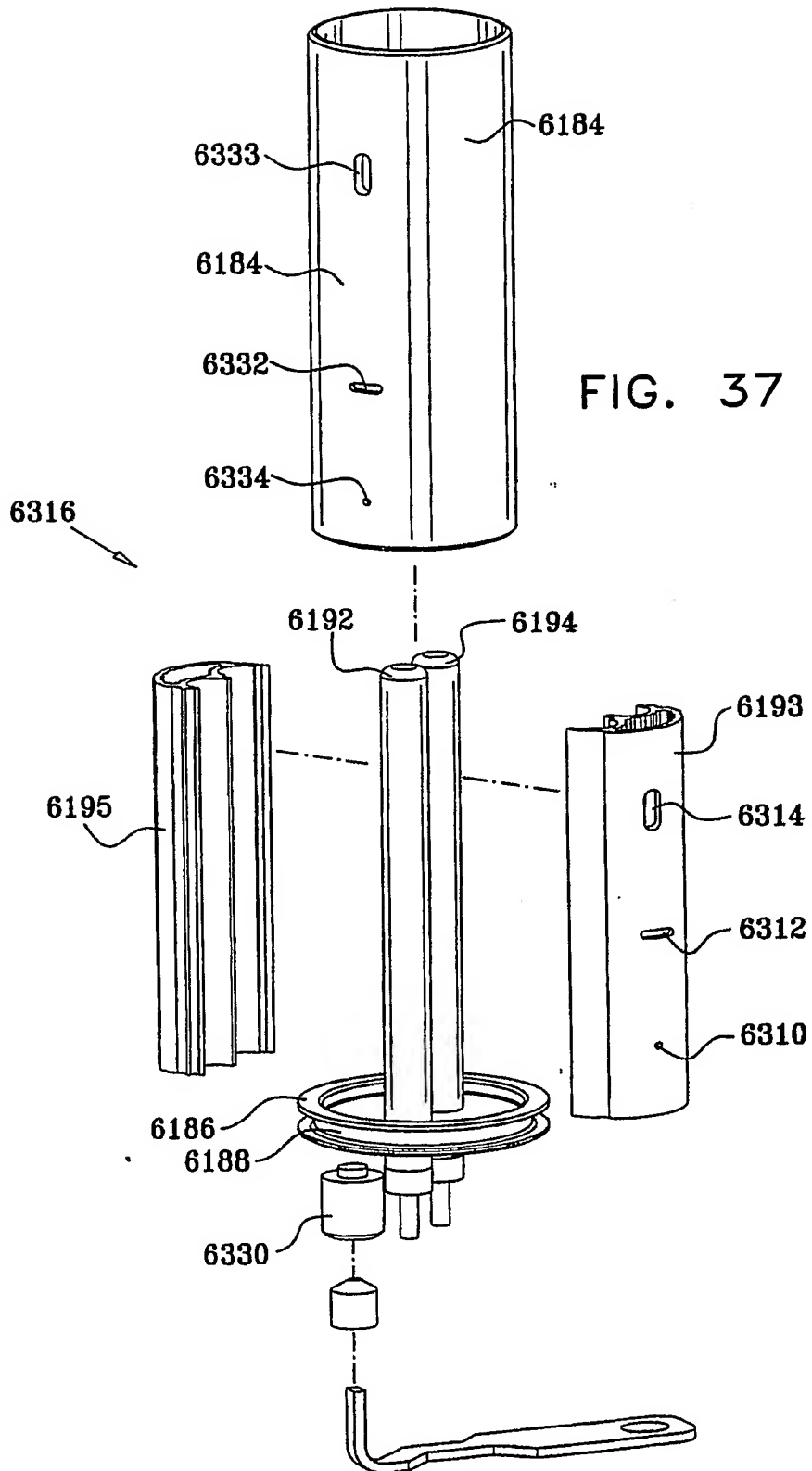


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FIG. 36



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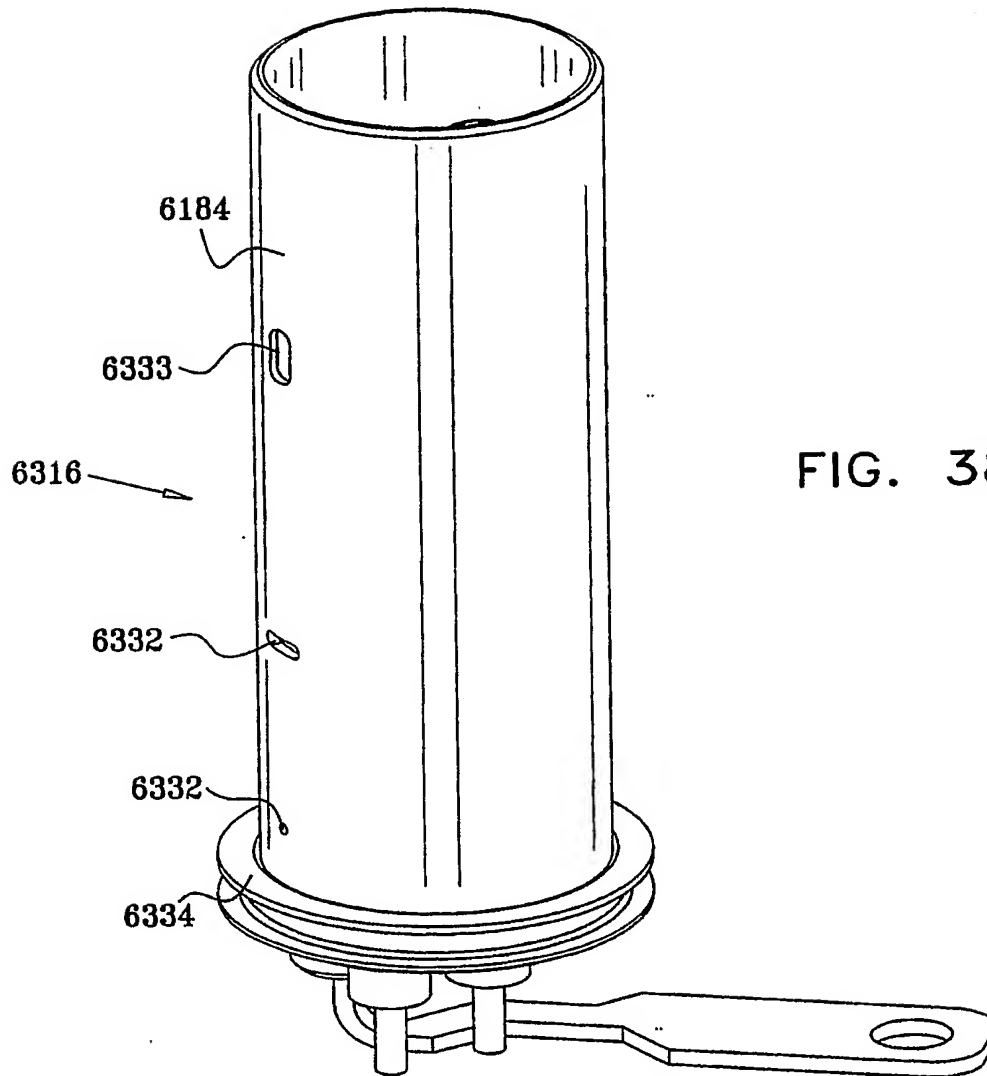


FIG. 38A

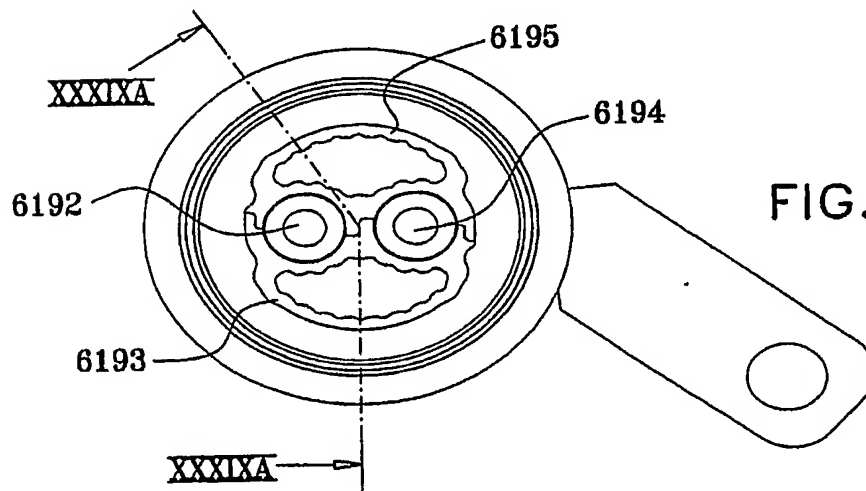


FIG. 38B

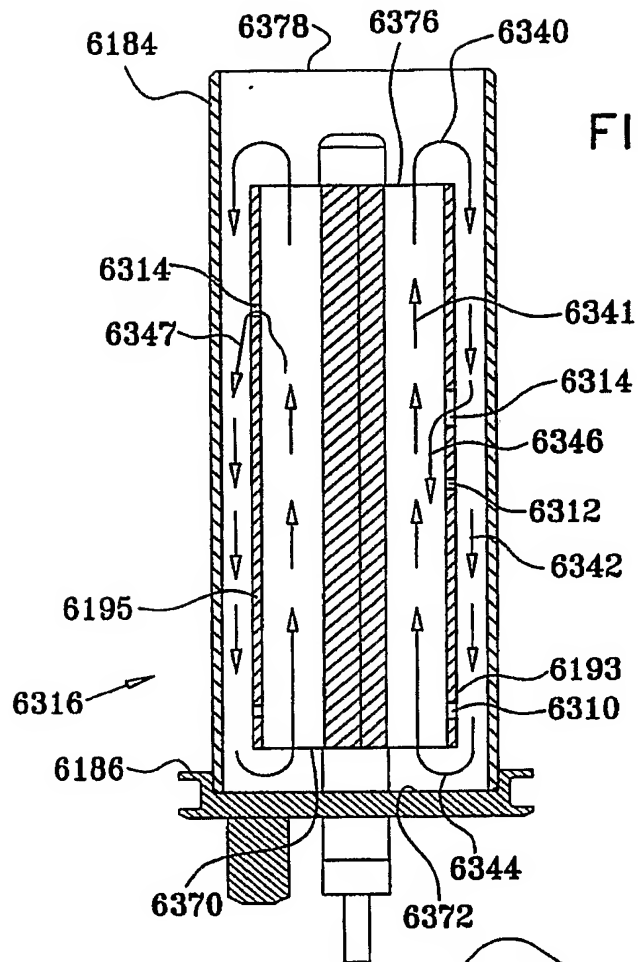


FIG. 39A

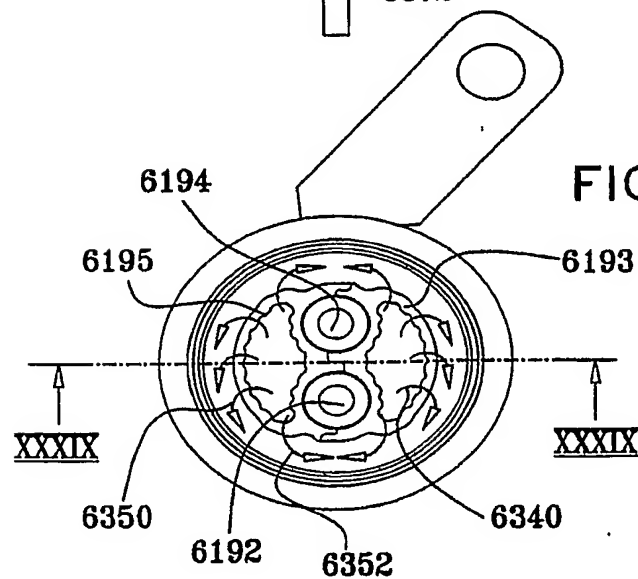


FIG. 39B

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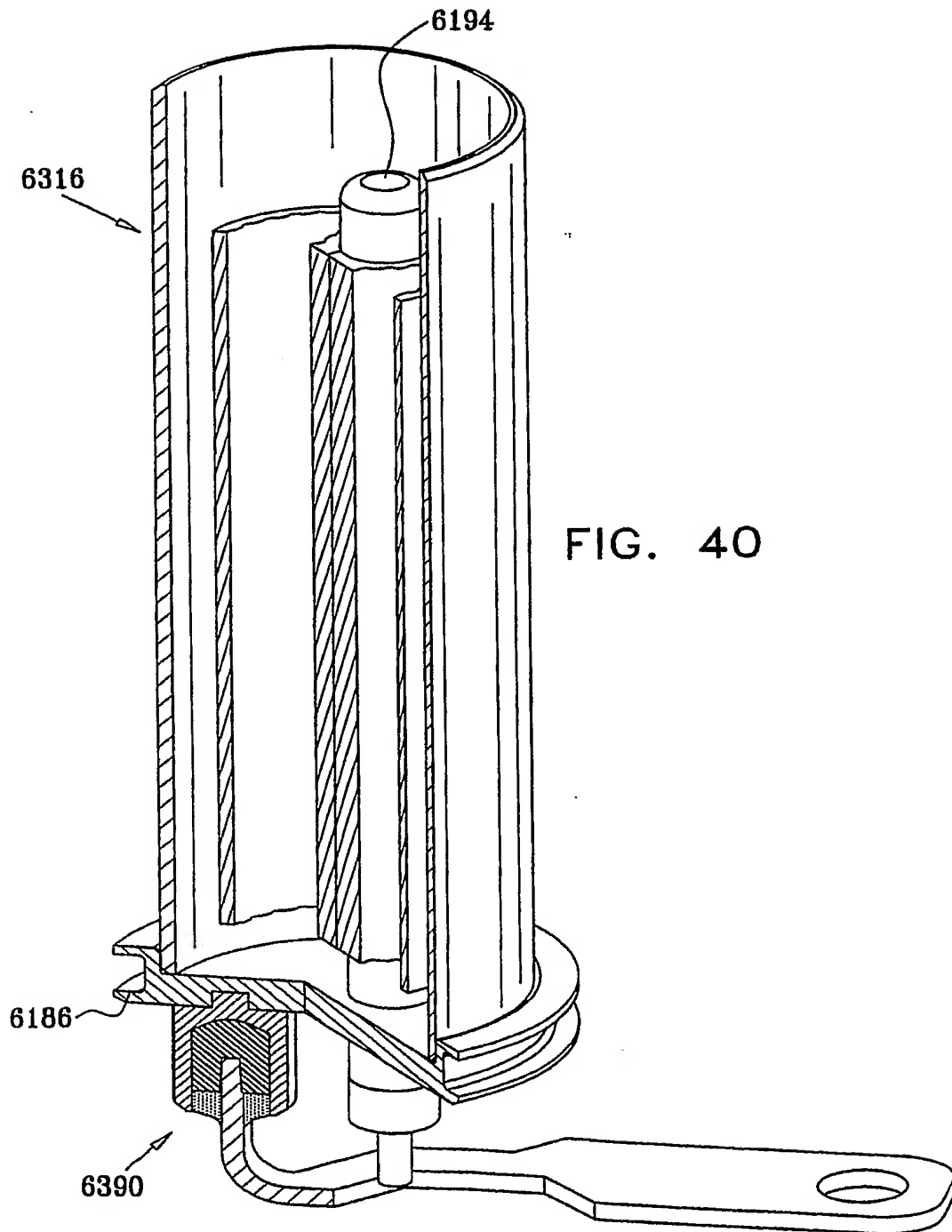
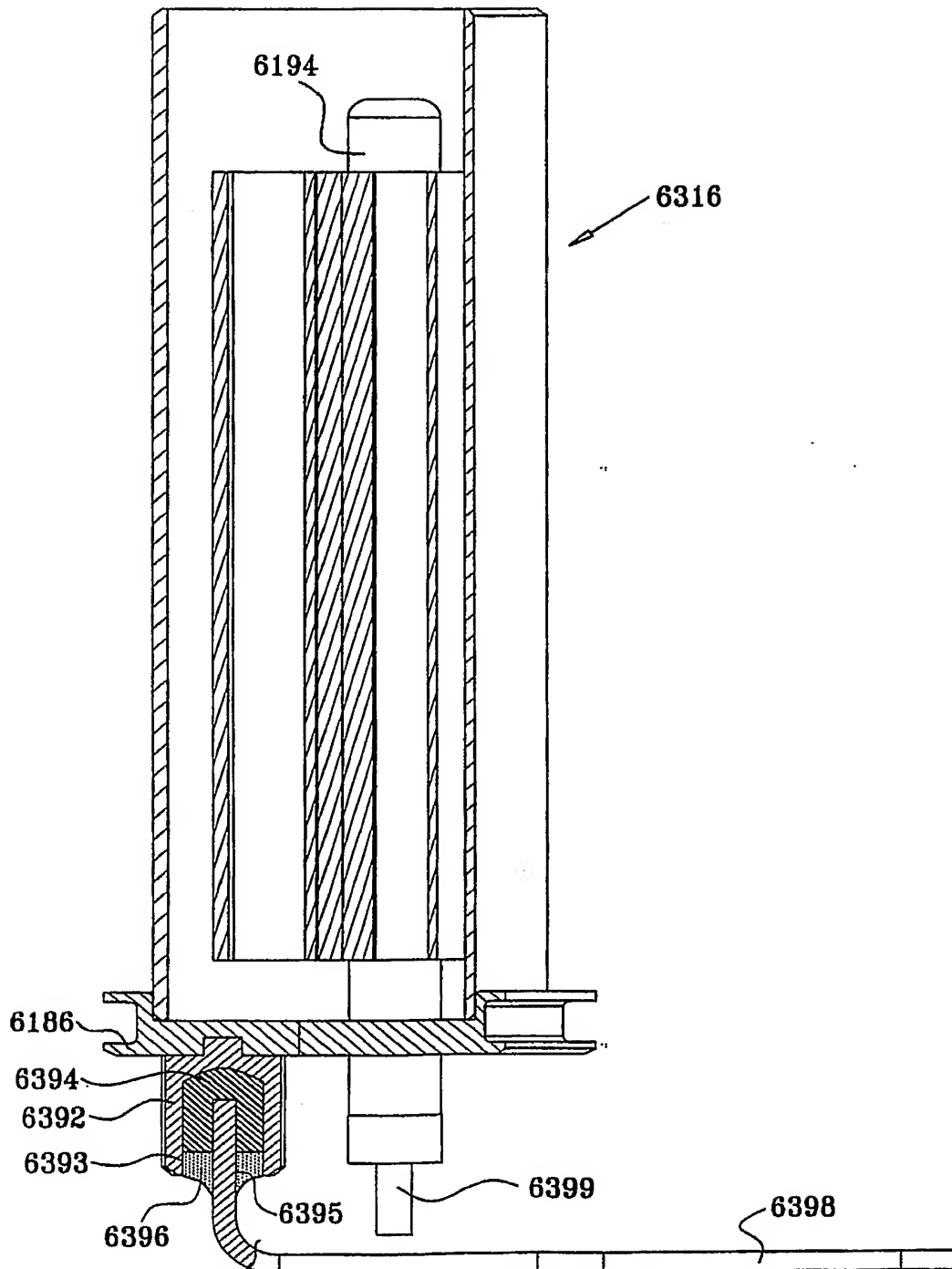


FIG. 41A



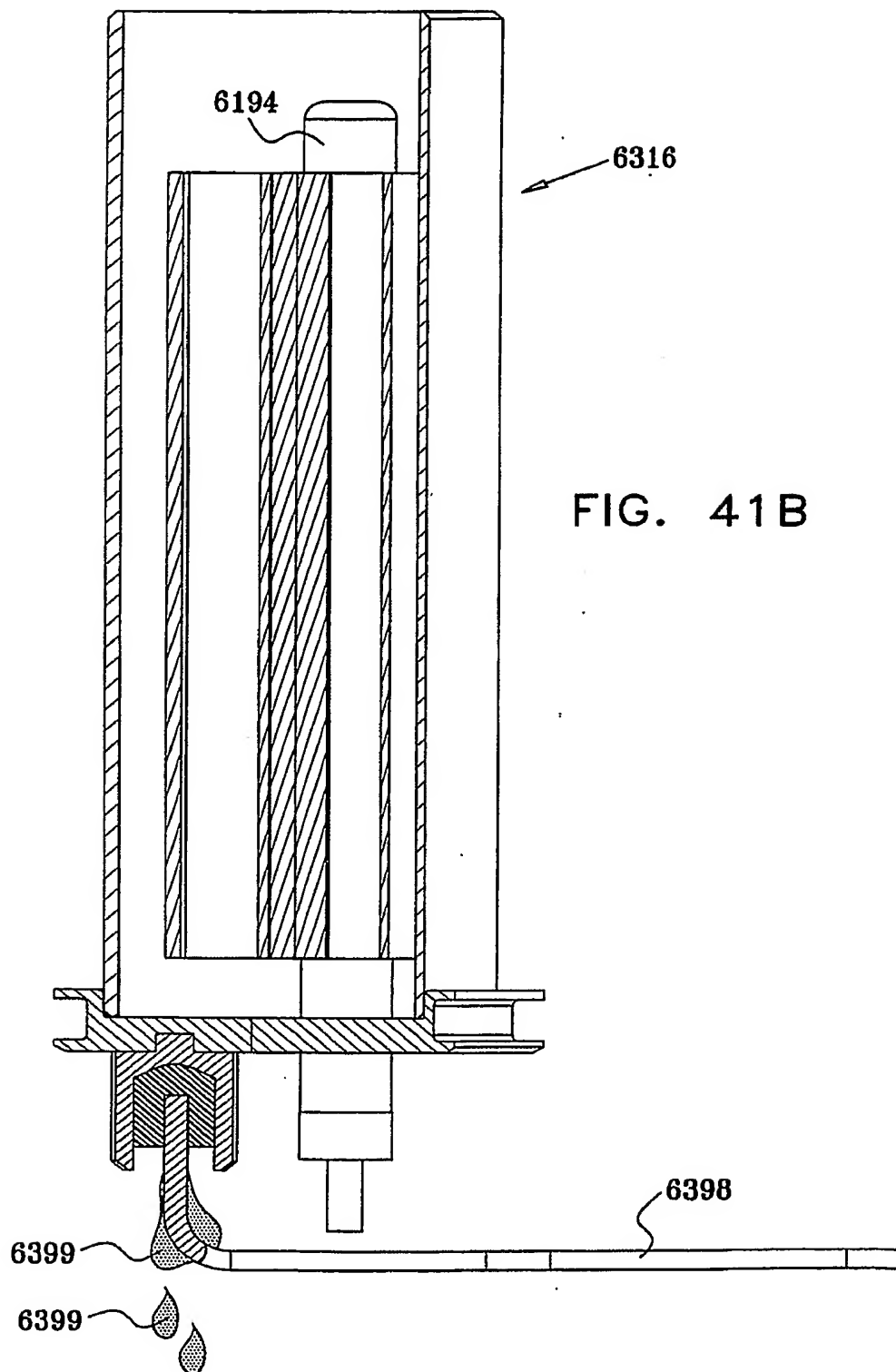


FIG. 41 B